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Usage, Utility, and Usability of the Knowledge Wall During the Global 2000 War Game

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EXECUTIVE SUMMARY

OBJECTIVE

Space and Naval Warfare Systems Center, San Diego's (SSC San Diego's) Command 21 project is directed at supporting the needs of senior decision makers and support staff in military command centers. As part of that effort, a prototype wall-sized shared display—or "Knowledge Wall" (K-Wall)—that fused mission-relevant information was created to support shared situation awareness, to facilitate group interaction, and to augment the decision-making capabilities of senior staff. The prototype K-Wall was designed to meet 14 user requirements that we had identified with a previous cognitive task analysis of potential K-Wall users. Prototype K-Walls were implemented ashore in the Joint Command Center of the Naval War College (NWC) and in the Command 21 Laboratory of SSC San Diego, and onboard the USS *Coronado* (AGF 11) for the Global 2000 War Game.

The Global War Game provides a venue for débuting potential high technology solutions for future naval needs. As such, Global 2000 afforded an invaluable opportunity to observe the prototype K-Wall undergoing extensive real-time usage in an operationally realistic setting by exactly the sort of experienced real Navy users for which it was intended.

To facilitate a usage, utility, and usability evaluation of the K-Wall, a research plan was developed for gathering both observational and automated data in a minimally invasive fashion during the game. This evaluation was focused on (a) the extent to which the design solutions met the 14 user requirements and whether there were new requirements that future versions of the K-Wall should meet, (b) whether the design of the information products (summary pages) supported the communication of mission-relevant information that could be easily fused to provide an integrated operational picture, and (c) whether there were usability, ergonomic, or other issues that need to be addressed by the Command 21 program for future success of the K-Wall and its satellite associated technologies.

RESULTS

We found that:

- The prototype K-Wall adequately supported most of the 14 user requirements. However, these were met with varying degrees of success.
- The K-Wall eradicated the need for a traditional 8-hour briefing cycle; instead, the K-Wall was used continuously for situation assessment.
- The "summary pages" shown on the K-Wall provided users high-level summarized views of the operational picture and a means to easily navigate through the "Knowledge Web" to get more detailed information. However, users had difficulty determining which content was new.
- The support applications used to produce pages and graphical content to populate them (Tac-Graph and SumMaker) were a success. However, information providers had difficulty tracking whether users had viewed their information products.
- K-Wall users found the K-Wall intuitive and easy to use and they preferred it to other information tools available to them. However, some usability issues related to interaction with the Wall and visibility of information on the Wall were identified.

RECOMMENDATIONS

The data provided important feedback, pointing to the specific needs that must be met by future Command 21 research and development efforts. Specifically, we recommend future K-Wall designs need to support improved:

- Tools to support attention management and change detection, including tools to support navigation to changed pages in the Knowledge Web.
- Tools and revised business processes to support improved multi-tiered collaboration, including feedback and guidance for information providers on content access of their pages.
- Design layouts to support improved text legibility.
- Information integration across functional areas.
- Tools and methods to communicate information age and source on the summary pages.

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1. INTRODUCTION

1.1. PREVIOUS RESEARCH AND COMMAND CENTER NEEDS

The U.S. Navy is increasingly conducting missions outside the bounds of traditional warfare. These missions are often conducted with fewer personnel than in the past, and with command and control that is more distributed in nature. Such mission characteristics do not always fit well with the methods, technologies, and compatibilities of current command, control, communications, computers, and intelligence (C^4I) systems. Improvements in display systems, information management tools, and human–computer interfaces (HCI) are needed to support decision processes, improve situation awareness (SA) (Endsley, 1995), improve combat team interactions, and enable the tactical team to recognize critical events and operate within the rules of engagement. The Command 21 project of the Space and Naval Warfare Systems Center, San Diego (SSC San Diego) is working toward providing such improvements.

Previous interviews with Joint Operation Center (JOC) senior staff (specifically, Battle Watch Captains [BWCs]) established a general need for tools to support shared SA and decision-making in the JOC (Miller & Klein, 1998; Moore & Averett, 1999). These analyses identified the existing Concept of Operations (CONOPS) for the JOC and revealed an important need for improved displays and information management systems. In the current CONOPS, information products that are generated by anchor desk personnel for senior staff are distributed continuously. These products also form the basis for formal briefs that are given at fixed intervals (typically, three times a day) for the Admiral. Between briefs, BWCs and Assistant Battle Watch Captains (ABWCs) monitor events primarily by verbally interacting with anchor desk personnel and others outside the JOC to remain constantly apprised of the operational situation. Moore and Averett uncovered a critical JOC need for improved technologies to support BWCs in maintaining SA and for continually visualizing the "big picture." In structured interviews, BWCs reported finding the tasks of gathering, fusing, and disseminating operational information both time-consuming and error-prone. BWCs need better ways of acquiring SA rapidly and then disseminating that awareness to support shared SA and to facilitate decision-making for senior staff. What is needed is a way of visualizing mission-status in a continuous fashion that does away with the 8-hour briefing cycle altogether.

1.2. KNOWLEDGE WALL CONCEPT AND DESIGN FOR GLOBAL 2000

SSC San Diego has been developing the "Knowledge Wall" (K-Wall) concept as a solution to these needs (see Figure 1). The K-Wall is a wall-sized shared display consisting of contiguous display windows that bring together information from multiple sources. The idea behind the K-Wall is that providing a processed and fused presentation of the "information space" on a single large display should support cognitive processes such as data integration, pattern recognition, event memory, and distributed cognition amongst its users. The K-Wall is intended to be large enough to provide a shared operational picture to multiple personnel to promote shared SA and to provide focus for collaboration among its users.

In order to determine the specific K-Wall information and functionality requirements for a Navy JOC, a series of structured interviews were conducted by SSC San Diego subject matter experts (Smallman, et al., 2001). The participants in the interviews were senior level personnel (Admirals, BWCs, ABWCs) and JOC anchor desk personnel (J2, J3, J6, JAG, etc.) from elements of Third Fleet,
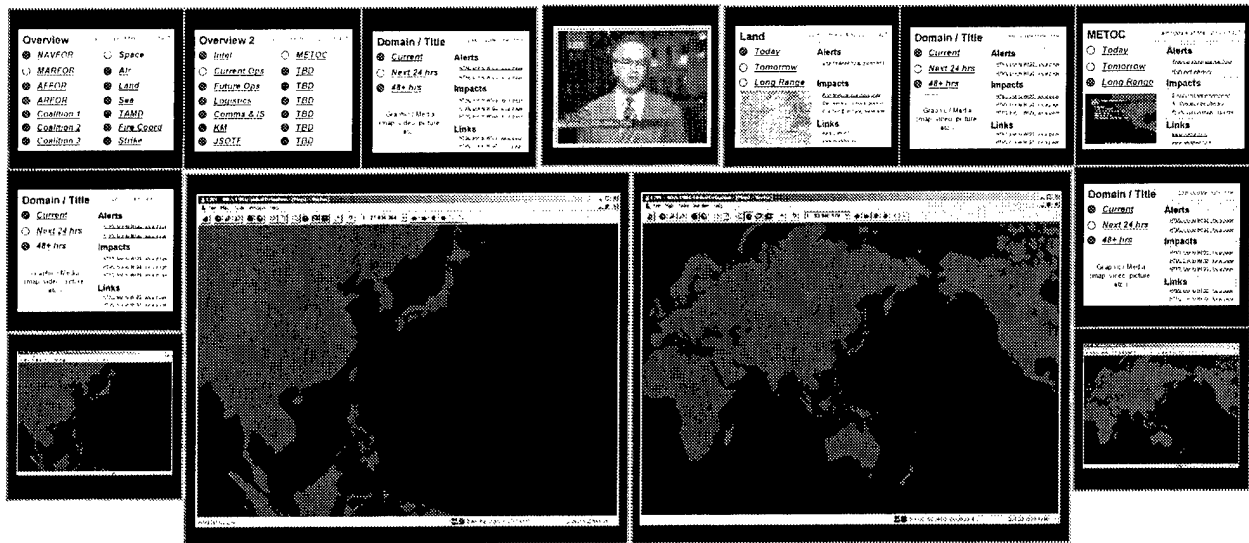
Figure 1. The K-Wall integrates mission-relevant information from a variety of sources.

Command Carrier Group 1 (CCG1), and Command Carrier Group 3 (CCG3) who planned to partici-
pate in the Global 2000 War Game. The interviews focused on the K-Wall in the context of its
operational use during a mission. Analysis of the responses led to the identification of 14 critical user
requirements that the K-Wall must meet. These 14 requirements could be categorized into the Gen-
eral, Format, Content, and Feature requirements for an initial K-Wall prototype. The requirements
and the design solutions implemented in the initial K-Wall prototype are shown in Table 1.

To provide knowledge management in a Web-centric fashion, the K-Wall is an html-based tool
that can be roughly conceptualized as a multi-screen Web browser. To provide shared SA, the K-
Wall is a shared display. Of course, how well simply sharing information promotes shared SA is
obviously an open question. In fact, several recent empirical studies addressing this question have
found mixed results (Farley et al., 1998; Bolstad & Endsley, 1999). However, given the time con-
straints of the prototype development effort, it was decided that this was the most obvious first solu-
tion to the requirement. To provide integrated information, the K-Wall displays the status of the vari-
ous functional areas, whose anchor desks are providing mission-relevant information in the form of
summary pages. To provide an intuitive graphical interface, the K-Wall displays graphical infor-
mation where possible; some of these graphics were generated by a tactical graphics (TacGraph)
support application created specially for the purpose (Bank & Moore, 2000). To support a consistent
format for its users, the K-Wall features summary pages that were developed using a support appli-
cation called SumMaker created specially for the purpose (Averett & Moore, 2000). To support a
tactical focus, the K-Wall allows tactical displays such as Command and Control PC (C2PC) tactical
software (currently used by U.S. Marine Corps and other U.S. military organizations) to be displayed.
To show supplemental information, the K-Wall features summary pages. To display mission goals
and objectives, this initial K-Wall prototype can simply display a text document listing those. Anchor
desk information products may be displayed using links provided on the summary pages. Collabora-
tion is supported by enabling collaborative tools (such as InfoWorkspace, NetMeeting, etc.) to be run
in a window on the K-Wall. In this first prototype wall, cognitive support is limited to displaying the
outputs from a limited number of nonintegrated cognitive support tools. The need for a flexible
configuration is supported by providing a control screen that allows any page to be viewable in any
display, and to make visible a host of commercial off-the-shelf (COTS) and government off-the-shelf

(GOTS) software tools. To support drill-down, the K-Wall is populated with html-based summary pages that are the first level in a hierarchy of information that can be accessed via links to more detailed information. There is no current display of information age and reliability on the K-Wall apart from text-flags that indicate the last time a given page was modified. To support tactical overlays, the K-Wall supports the presentation of TacGraph-generated augmented and modified tactical displays (Bank & Moore, 2000). It was this initial K-Wall design that was implemented and then evaluated at the Global 2000 War Game.

Table 1. The 14 K-Wall user requirements and the design capabilities provided to meet them in the prototype K-Wall for Global 2000.

	User Requirement	K-Wall Prototype Design Capability
General	Shared SA	Shared display
	Integrated Information	Co-located summary pages
Format	Intuitive Graphical Interface	Graphical presentation when possible
	Consistency	Consistent format summary pages
Content	Tactical Focus	Ability to view multiple tactical displays
	Supplemental Information	Summary pages on peripheral displays
	Mission goals and objectives	Text document
	Anchor Desk Output	Summary pages with links to more info
	Connectivity/Collaboration	Collaboration tools (IWS)
	Cognitive Support	Limited output from nonintegrated cognitive support tools
Feature	Flexible Configuration	Any pages viewable in any display
	Drill-Down	Multiple scalable views, links to more info
	Information Age and Reliability	–
	Tactical Overlays	Various software for tactical graphic presentation

1.3. THE K-WALL AT GLOBAL 2000

1.3.1. The Global 2000 War Game

The Global 2000 War Game was played over a period of 2 weeks (14–25 August 2000). Of the 10 working days, it included 1 day of training, 6 days of operational play and 2½ days of post-game Executive Sessions. The game consisted of three operational phases: a pre-hostilities phase (Phase 1), a hostilities phase (Phase 2), and a post-hostilities phase (Phase 3). The command structure consisted of a Commander Joint Task Force (CJTF), a Commander in Chief (CINC), and a National Command Authority (NCA) supported by the component commanders and personnel assigned to one of 13 functional areas[1]. The K-Wall prototype provided the operational picture to the CJTF and CINC staff

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[1] The thirteen functional areas designated for use during Global 2000: Air Defense (AD), Deep Strike (DS), Effects (Eff), Fires Coordination (FC), Ground Control/Closed Air Support (GC), Intelligence Surveillance and Reconnaissance (ISR), Information Warfare (IW), Logistics (Log), Operational Maneuver From the Sea (OMFTS), Special Operations Forces (SOF), Sea Control (SC), Rear Security (RS), Theater Missile Defense (TMD).

by displaying information products produced by the anchor desks elements making up these functional areas. The information products were continually updated over time during game play. In practice, this meant that the pages were updated multiple times every hour.

1.3.2. Initial K-Wall Implementation

Initial K-Wall prototypes were implemented in the Joint Command Center (JCC) at the NWC during the Global 2000 game. One purpose of the K-Wall is to support collaboration and shared SA across remote locations so another implementation of the K-Wall was in the Crisis Action Center (CAC) on the USS *Coronado* (AGF 11). (Another version of the K-Wall was constructed in the Command 21 Laboratory at SSC San Diego for research and development purposes).

The initial K-Wall prototype, shown in Figure 2 at the NWC, consisted of two large focus monitors (58.25-inch-diagonal SmartBoard rear projection displays) surrounded by ten smaller (21-inch) peripheral monitors. An additional 21-inch monitor was included to provide Video/VTC capabilities. By default, the large focus monitors displayed tactical information while supplemental information, i.e., the summary page output from the 13 functional areas, was displayed on the smaller peripheral monitors. The intent of this design was to provide the K-Wall user an intuitive visual metaphor for the role of the supplemental data, specifically, to embed the tactical data in the context of more detailed supplemental information. Any information on the smaller monitors could easily and quickly be "brought into focus" on either of the central monitors using custom-built K-Wall HCI created for the purpose.

Figure 2. The initial Global 2000 K-Wall prototype implementation (here at the JCC at the NWC).

Two sets of mice and keyboards provided input to the K-Wall. In general, one of these inputs was controlled by one of the K-Wall technologists and the second was provided to the K-Wall users (senior staff). The focus monitors also provided touch screen interaction capabilities.

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1.3.3. Business Processes

The K-Wall was intended to provide its users (senior staff: CJTF at the JCC and CINC on the *Coronado*) with a shared, integrated view of the operational situation by displaying information from multiple sources (the 13 functional areas) in a single location. The basic K-Wall system setup that was used during Global 2000 is shown in Figure 3. Information products were created and continually updated at the functional area anchor desks and then stored in shared locations accessible to the computers systems of all Global 2000 players. Many of these products (such as summary pages, see below) were created with the express purpose of populating the K-Wall. The K-Wall users controlled the K-Wall content by making requests to change or move the information displayed on the K-Wall.
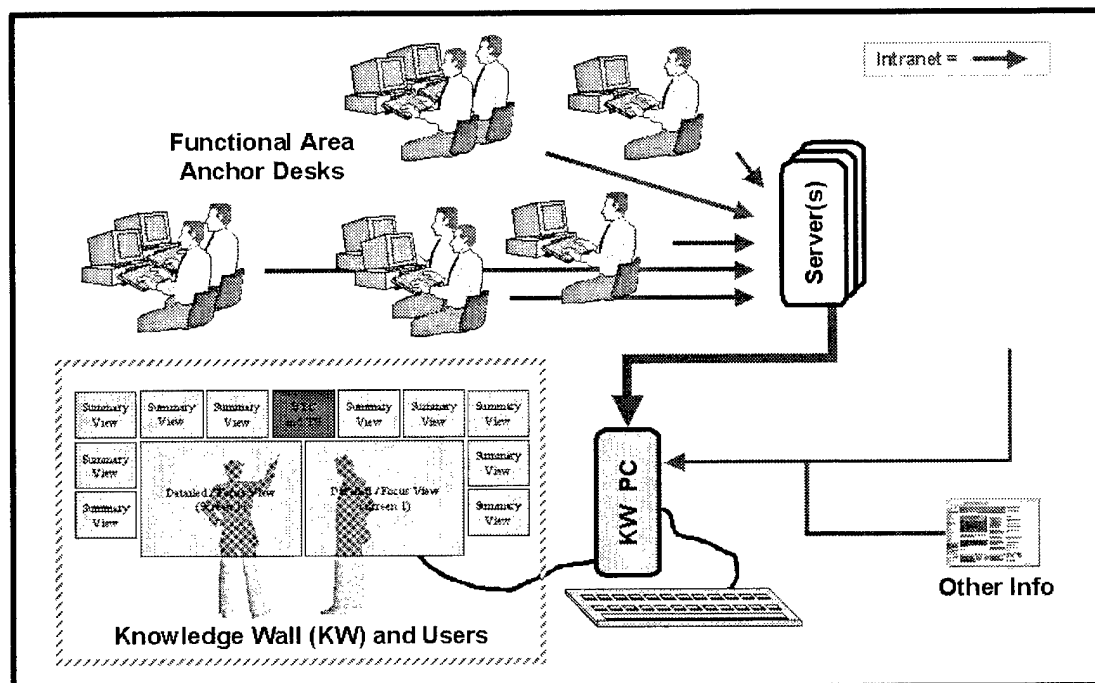
Figure 3. The basic K-Wall system setup as implemented during Global 2000.

K-Wall Users. Figure 4 shows the layout of the JCC during the Global 2000 War Game. The positions of the primary K-Wall users (CJTF, CoS, J2, J3, J4, J6, BWC, BW1, BW2), as well as of the K-Wall technologists and the JCC Knowledge Manager (KM), are shown in blue. Gray regions represent horizontal surfaces (tables) and hatched regions represent computer systems (laptop, computers on the command table, keyboards, and monitors). The K-Wall could display any of the information that was accessible to game players, including Web pages and other documents and tactical and other software. The K-Wall users controlled changes in the content and configuration of the information displayed on the K-Wall by making requests to the K-Wall operator (a K-Wall technologist or one the CJTF staff dedicated to K-Wall operation) or by taking control of the wall themselves.
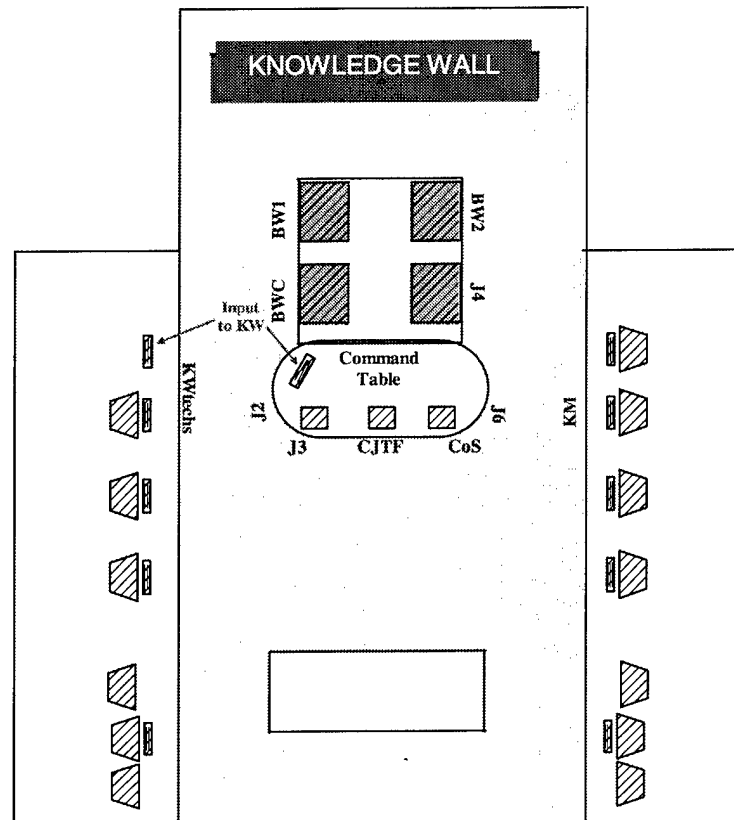
Figure 4. The layout of the JCC at the NWC during Global 2000 (top-down view).

Information Products and Information Providers. During the game, summary pages and other information products from the 13 functional areas were created to be displayed on the K-Wall (and elsewhere). An example summary page is shown in Figure 5. The summary pages consisted of five parts:

1. Color-coded status indicators for the short-term (Today), mid-term (Tomorrow), and long-term (Long-Range) time periods

2. Important alerts to new information concerning the functional area

3. Impacts and implications of those alerts

4. Related links for more information

5. A graphic related to the alerts or current status

This consistent format was imposed to meet the user requirement for consistency (see Table 1). Consistency in the placement of information on displays is necessary to allow users to scan for information most efficiently (see Mayhew, 1992; Wickens, 1992). Color-coded status information was a prominent feature of the summary page. It was intended to support rapid SA of the overall mission status of the entire functional area through an intuitive graphical format. The concept was to enable the K-Wall user to rapidly acquire and integrate information from the various functional areas and to prioritize his or her knowledge retrieval with the K-Wall. The alerts, text, and pictures could be linked (using html hyperlinks) to other information to initiate drill-down to more detailed information.
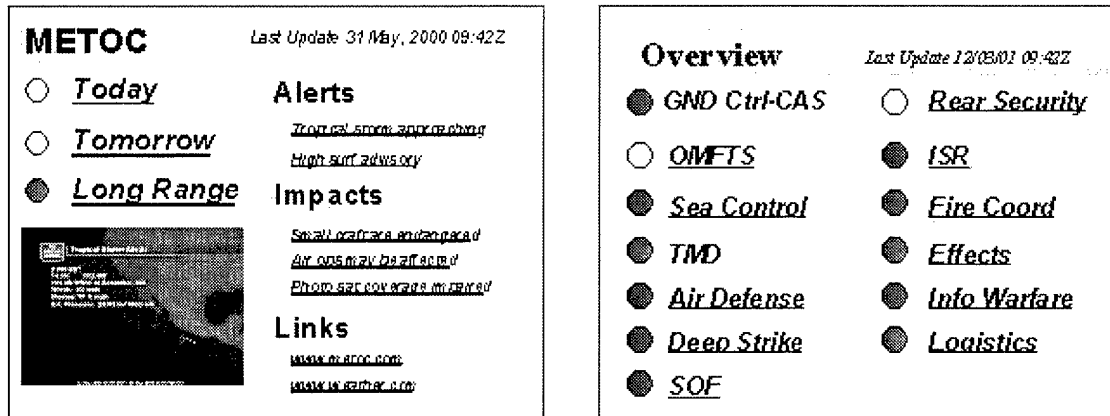
Figure 5. Example summary page (left) and Overview page (right).

P The intent was that certain aspects of the summary pages would remain constant (such as the functional area status for today, tomorrow, and long range, and the fixed location of the different types of information) to provide efficient integration of information across multiple summary pages. The figure also shows an Overview page, which displayed the "worst case" status value for each of the functional areas. This page was not initially part of the K-Wall design. However, as the K-Wall concept prototype matured, the need for such a page became clear as there were insufficient monitors to display a summary page for each functional area and numerous special-purpose pages. Thus, the Overview page was intended to give users an integrated summary across all the functional areas, including any that were not presently being displayed. The K-Wall technologists monitored the content of the summary pages and manually updated this Overview page over time.

rior to the beginning of operational play, at least one individual working in each functional area was chosen to be responsible for the creation of the summary pages. These individuals (hereafter referred to as "information providers") were provided with the SumMaker software (Averett & Moore, 2000), with which they could develop and update summary pages (see Figure 6). This software allowed them to edit the color of the status alerts, change the text and pictures, and create hyperlinks from the text and graphics to other information products, such as Microsoft Word documents, briefs, etc. They were briefly trained in its use prior to game play.

The information providers were also given the TacGraph tool (Bank & Moore, 2000), which allowed them to create interactive tactical pictures that also provided hyperlinks to other documents. An advantage of TacGraph was that this enabled tactical graphics to be published in html format and then later be edited, if needed (see Figure 7). This allowed for multi-level, graphics-based information products to be developed, and saved information providers considerable time because they were spared from their slow and inefficient old business process of creating single-use, single-level custom tactical graphics with a combination of nonintegrated applications (e.g., C2PC and PowerPoint). They received training on the use of these tools as well as on the intended content and usage of the summary pages. Information providers were encouraged to make use of this tool for briefing purposes.

Figure 6. The SumMaker interface.

Figure 7. Example output created with the TacGraph tool.

Each functional area's summary pages and the information products that they linked to were stored in shared folders so that they could easily be accessed by other game players. Access to each of the 13 functional area summary pages was available through the "channels" (favorites) menu on the K-Wall or through links in the Web-based War Game Information Grid System (WIGS).

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2. DATA COLLECTION

The constraints of collecting data during a real-time operational exercise where players could not be interrupted during the execution of their tasks led to the creation of a carefully tailored data collection plan.

2.1. DATA COLLECTION PLAN

The data collection effort was very focused in scope. It centered primarily on the usage of the K-Wall in the JCC at the NWC. Some observational data was also collected for the K-Wall onboard *Coronado*. One purpose of the data collection was to determine whether the K-Wall design had met the design goals by examining it in the context of operational use (during the Global 2000 War Game). Another goal was to establish usage patterns and identify utility and usability issues related to the K-Wall. The data collection plan had several objectives. It attempted to determine whether:

1. The K-Wall design solutions supported the 14 user requirements identified in the previous interviews and whether there were additional requirements that would require new K-Wall design features and content.

2. The information products (summary pages and others) met the information requirements of K-Wall users. In particular, whether the content and format of the summary pages provided the K-Wall users a consistent, intuitive representation of the status across the different functional areas that could be easily fused to provide an integrated picture of the operational situation.

3. There were usability or ergonomic issues related to K-Wall use or operation.

2.2. DATA COLLECTION TECHNIQUES

The data collection techniques employed during Global 2000 were restricted to passive observation and automated data collection. Because of the free flow and continuous nature of the game, no questionnaires that would disrupt play were given and direct questioning of players was limited. The K-Wall application software collected some data automatically while other data were recorded manually from direct observations and ergonomic measurements (see Appendix A for a summary).

The K-Wall was located in front of the "command table" in the JCC (see Figure 4), so that its primary users were the players that comprised the CJTF staff (CJTF, CoS, J2, J3, J4, J6, BWC, BW1, BW2). Other players that were located in the JCC, including those in the cells, could view the K-Wall, but this required them to turn around from their own computer systems—systems that were considerably more distant to the K-Wall. Therefore, the observational data collected came predominantly from the primary K-Wall users. However, observations of and comments made by other game players, including the functional area Commanders, functional area anchor desk personnel (i.e., the information providers to K-Wall), and visitors to the JCC were also collected when available.

2.2.1. Automated Data Collection

Automated data were collected in order to track Universal Resource Location (URL) access and changes in the configuration of displays of the K-Wall. This was an attractive means of collecting data because it was completely non-invasive. Two types of automated data collection were implemented. Logs of the usage on each display of the K-Wall were created at the beginning of each day

and updated any time a change was made. These logs included the address of the Web pages that were displayed on the K-Wall, when the URLs to these pages were accessed, and on which K-Wall monitor they were displayed. The usage logs were also updated every time a K-Wall operation was performed, such as when the contents in one of the peripheral monitors was brought into focus on one of the central monitors, when windows were manually refreshed, minimized, or maximized, and when one of four preset configurations of information was chosen[2]. The usage logs did not include information about other tools or software that was displayed on the K-Wall, unless they were accessed via the K-Wall application (i.e., via a URL).

The second type of automatically collected data came from screen captures of the entire K-Wall, which provided insights into its usage by showing actual content and configuration. These were also time stamped and they were taken automatically every 5 minutes.

2.2.2. Observational Data Collection

As is usually the case when collecting data non-invasively in a real-world, operational setting, much of the data collection was informal and observational—particularly given the constraints discussed above. However, this kind of data often proves extremely informative due to its broader scope and in-context nature. Observational data collected during the game related to several different aspects of the K-Wall, including:

- *Critical events and situations*, which allowed the other data to be put into a context over time. Critical events were broken down into (a) those events that caused a modification in the usage pattern of the K-Wall, and (b) those events that were determined to be mission-critical at the daily outbriefs and based on observer comments.
- *K-Wall usage patterns,* including which tools and URLs K-Wall users accessed and how the K-Wall displays are configured.
- *User preferences,* in terms of how much users liked or disliked the K-Wall and its features.
- *K-Wall usability,* including issues related to the ease and intuitiveness of interacting with the K-Wall.
- *Suggestions for new requirements*, in terms of the content, features, and tools of the K-Wall.
- *Visibility issues,* including the legibility of text and graphics on the K-Wall, etc.
- *Ergonomic issues* related to the K-Wall, such as those associated with occlusions, monitor glare, room layout, communication between personnel, etc.

Each of these data sets was gathered from different sources. For example, issues related to the update rates of the summary pages could be established from a range of observations including both the automated data collection (described above) and records of overt verbalizations. Other data, such as user preferences, could only be obtained via interrogation and from verbal comments. The specific data sources used to collect observational data included:

1. *Logging of critical events* that caused a change in K-Wall use.

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[2] Hiding a K-Wall window allowed for other non-Web based software (primarily C2PC) to be displayed in its place. The presets were designed to give users a tactical focus by hiding at least one of the focus windows. The four presets were: (1) all windows shown except 9 (left focus window) and 10 (right focus window) hidden; (2) all windows shown except 8 (bottom left window) and 9; (3) all windows shown except 10 and 11 (bottom right window); and (4) all windows shown except 8, 9, 10, and 11 hidden.

2. *Time sampling* of the content and configuration of the K-Wall, as well as which tools and summary pages were being used or viewed (discussed).

3. *Observations* of verbal and nonverbal behaviors of the K-Wall users as they related to usability issues, new requirements, preferences, and visibility.

4. *Probing* of specific K-Wall users about the above issues (usability, requirement, preference, and visibility) if observations of behavior did not provide enough information.

5. *Measurements and descriptions* of the variables that related to the K-Wall's ergonomic use.

2.3. SCHEDULE OF DATA COLLECTION

SSC San Diego observers were located in the JCC itself, in close proximity to the K-Wall and its primary users (see the JCC layout, Figure 4), allowing data to be collected almost continuously during the game. The specific data collection techniques were employed according to a predetermined schedule:

1. The logs of critical events and situation changes were updated from moment to moment, as they occurred.

2. Automated logs of URL access and changes in the configuration of displays of the K-Wall were updated any time a change occurred.

3. Screen captures of K-Wall content were automatically taken every 5 minutes.

4. Time sampling of usage patterns (tool use and K-Wall monitor content) were manually recorded every hour.

5. Observational data collection and probing of user responses regarding usability issues, new requirements, preferences, and visibility across most primary K-Wall users occurred throughout the game.

2.4. OTHER SOURCES OF OBSERVATIONAL DATA

The reported data consists primarily of that data collected using the methods described above. However, several other sources of data that included observations about the K-Wall and its usage during the game were also made available (by game personnel and other data collection teams working at Global 2000) and the data from these sources is also included. These sources are discussed below.

Knowledge Managers

The observational data include comments made during discussions with the Knowledge Managers (KMs) and made during the daily KM meetings. In Global 2000, a team of personnel was given the role of supporting and evaluating knowledge management. One of the many responsibilities of this role included supporting players in the effective use of the tools made available to them during the game. The KMs provided invaluable insights into many issues related to the K-Wall because of their roles as facilitators for the use of the K-Wall and other information technologies. These perceptions were also documented and made available to members of the Command 21 program team during Global 2000. The documented comments also included a survey that contained a question specifically asking about the K-Wall and its impact. These data were extremely useful because they provided insight into the perceptions and issues expressed by the players not located in the JCC, including those of the information providers that produced the summary pages that were displayed on the K-Wall.

WIGS

Documents stored on WIGS were also made available and provided important information. This was a Web-based system that allowed players to access various game-related documents, such as daily briefs, rules of engagement, news updates, and functional area summary pages. Game players could access any of the documents located in WIGS using their Web browser. The most valuable information available on WIGS, in terms of the current data collection effort, was the situation summaries (the SitSum) that were updated continuously. This information allowed critical events to be identified, which enabled the manual recording of these events to be related in time to both the automated and observational data collection.

Executive Sessions

Discussions during preparation for post-game Executive Sessions and during the sessions themselves included many important comments, from primary K-Wall users and others, regarding the K-Wall and its impact during the game.

3. RESULTS

Appendix A contains all of the observational data collected during Global 2000. These comments fell into four main categories, which related to:

1. The initial requirements identified in previous interviews and which the K-Wall was designed to meet.

2. The design, content, and tools of the summary pages.

3. Usability and usage of the K-Wall.

4. Other emerging themes.

The results are organized around these themes and include discussion of the observational data, as well as any appropriate analyses conducted on the data collected automatically (i.e., the K-Wall usage logs and screen captures). Appendix B contains tables of the automated data presented in the figures in the results section.

3.1. INFORMATION REQUIREMENTS

As discussed above, a series of structured interviews with JOC senior staff conducted by SSC San Diego (Moore & Averett, 1999; Smallman et al., 2001) led to the identification of 14 critical user requirements that the K-Wall must meet. These requirements, given in Table 1, were grouped into four categories: General, Format, Content, and Features. One goal of the current data collection effort was to determine how well the initial K-Wall implementation met these requirements. Specifically, it attempted to determine whether:

- The K-Wall design solutions support the user requirements (see Table 1).

- The interviews identified the right information requirements.

- There are additional requirements that will require new K-Wall design features and content.

Each of the 14 user requirements identified in the interviews is discussed below, with paraphrased representative comments and supporting data, when available, that indicate how well each requirement was met.

3.1.1. General Requirement 1: Situation Awareness

The K-Wall attempted to meet users' need for shared SA by bringing multiple sources of information together on a single shared display. Unfortunately, no formal measures of SA could be taken during Global 2000. This was due to constraints imposed on the data collection procedures used—questionnaires given to the players or other formal procedures would have disrupted game play. However, users perceptions of how well SA was supported can be discerned from the observed comments of JCC staff. All of these comments should be considered in light of the fact that there was a limited number of tools available to the game players which they could take advantage of to acquire and maintain SA. In

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

general, most of the relevant comments made by K-Wall users suggested that they believed that the K-Wall was the best tool available to them for the acquisition of SA and that it provided support for SA reasonably well. In particular, the comments reflect the perception that personnel who had access to the K-Wall were able to acquire SA more easily than those who did not have this access. Typical comments included:

- It was useful for the CJTF; it was the only tool available . . . normally he would get SA from radios, people talking to each other . . . here the K-Wall was the only way to get SA.[3]
- We need a common picture that gives instant SA to the commander when they walk into the room . . . this is a pretty interesting first step.
- Life would have been miserable if I didn't have this . . . because I would have been constantly pinging the other guys about what's going on.
- The CJTF did not have to 2nd guess commanders because of comfort he had. . . .
- SA increased in the CJTF but not component commands.
- We didn't do a briefing at 8 o'clock, 1 o'clock . . . we didn't need to be brought up to date because we were always up to date. . . .
- Speed of Command was increased by the improved SA of the CJTF. The K-Wall was a factor in terms of improved speed of command. SA was not good in the functional cells.
- [Regarding "working information into knowledge"] When I walked around during game play, this [the K-Wall] was the only place it was happening.
- The K-Wall is valuable in giving all a sense of what's going on, especially the CJTF and the CINC.
- The K-Wall does a reasonable job of keeping awareness level to the CJTF and his staff.
- I found the K-Wall useful. The CJTF depends on the K-Wall almost entirely for awareness. . . .

3.1.2. General Requirement 2: Integrated Information

Another general requirement that the K-Wall was designed to meet was the need to display integrated information. Again, the design of the K-Wall addressed this need by bringing multiple sources of information together on a single display. The observed comments made by K-Wall users suggest that they believed that displaying information typically distributed across multiple systems simultaneously, in a single display, was a step toward providing integration of the information provided by the different functional areas. However, the comments also reflect the feeling that it was still difficult to fuse the information that was displayed on the K-Wall to form a sufficiently integrated picture of the operational situation across functional areas. Comments related to this issue included:

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

- Only the CJTF can look at all the screens at the same time. [Those without a K-Wall cannot. . . .]
- I see this as valuable because we can put different formats up there to discuss things.

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[3] Note: When observational data are presented in the following sections, italicized text indicates an observed behavior; text that is not italicized represents a comment or answer to probe.

- The K-Wall was a good first step. We need better integration . . . it was hard to see everything. . . .
- The CJTF is the integrator because of more screens.
- An advantage we had over the component commanders was not having a single page but multiple screens.
- It's hard to integrate the stoplights [status alerts]. . . .
- It allowed us to look at the same information at the same time and discuss it.
- The information presented on the wall was not fused from relevant functional areas. However, it gave the false impression that it was. . . .

3.1.3. Format Requirements 1 and 2: Intuitive, Graphical, and Consistent

The interviews revealed a need for the information presented on the K-Wall to be in a consistent format that was intuitive and graphical. In order to meet this need, information providers were trained to populate the K-Wall with summary pages, html pages that had a predetermined layout and format. A later section of the Results is devoted to issues related to the content and format of these summary pages (see section 3.2.2). In order to support graphical information on the K-Wall, the functional area anchor desk personnel were encouraged to use graphical representations of information when possible. They were also provided with the TacGraph tool with which they could provide graphical tactical information to be published on the K-Wall. The usage of this tool is

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

discussed in sections 3.1.4 and 3.1.13. The comments regarding the format of the K-Wall suggest that, although the format of the K-Wall was "fairly" intuitive, there were problems with consistency that were not resolved during the game. These problems stemmed from a lack of standardization of the representation of information on the K-Wall, especially across the different military forces. Representative comments included:

- The technology, a lot of it being the K-Wall, was fairly intuitive. . . .
- An observed problem is that navy personnel don't know what the army symbols are—a suggestion was made that there should be a roll-over function in TacGraph that shows a description of a unit.
- There is no way to have one metric for all the functional areas. . . . If we were together for a longer time, a metric would develop.
- We need standards of use (e.g., colors used, processes completed, level of detail, purposes, etc.). . . .
- We need to determine what level of information you see at first blush.

3.1.4. Content Requirement 1: Tactical Focus

A desire expressed by users in the interviews was for multiple tactical displays as the focus of the K-Wall. The K-Wall provided two large, side-by-side focus monitors that were intended to meet the need for a tactical focus. The primary software used to generate detailed tactical information during Global 2000 was C2PC. Another common way that information producers represented

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

tactical information, at a less detailed level than C2PC, was to link pictures produced using the TacGraph tool to the functional area summary pages.

Tactical information was included in the focus of the K-Wall for a significant proportion of the game. Analysis of the screen captures of the K-Wall revealed that tactical information provided by C2PC or TacGraph was displayed on at least one of the K-Wall focus monitors 34% of the time. However, tactical data was rarely the *only* focus of the K-Wall—*both* focus monitors contained tactical information only 8% of the time. Figure 8 shows the percent of time that C2PC was running or a summary page link containing a TacGraph picture was being displayed on one or both of the focus monitors as a function of the operational phase of the game.
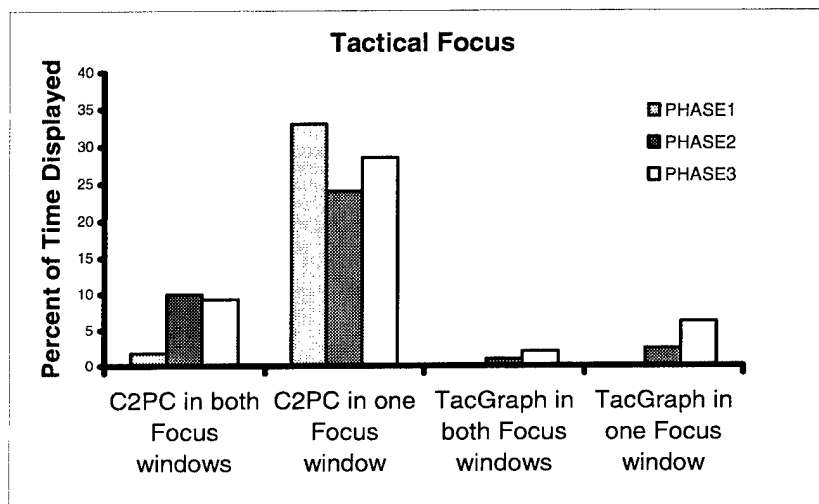
Figure 8. The percentage of time that tactical information was displayed in one or both of the K-Wall focus displays (Monitors 9 and 10) as a function of format of information and operational phase.

3.1.5. Content Requirement 2: Supplemental Information

In order to display other information besides tactical, the K-Wall design provided 10 small, peripheral monitors surrounding the two focus monitors (see Figure 1). The observed behavior of the K-Wall users demonstrated both confirmation of the need for this information and a potential design problem with K-Wall layout. Although the information on these monitors was frequently viewed or discussed, it was almost always brought into focus on one of the larger central monitors in order for K-Wall users to be able to read it. This was especially the case when any links from the summary pages were being viewed. This behavior suggests, that although users were *very* interested in seeing non-tactical information on the K-Wall, the small peripheral monitors only provided some information (such as changes in the color of the status indicators or in the color of the links text), and that they were not sufficiently large to provide the information that users wanted to see and read (also see the discussion of visibility issues in section 3.3.2).

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

3.1.6. Content Requirement 3: Mission Goals and Objectives

A requirement identified in the interviews was for the K-Wall to provide access to mission goals and objectives. A goal of the K-Wall design was to meet the need to visualize goals, plans, and mission status, however no single monitor or location was dedicated to provide this information. The information providers did make this type of information available in links from the functional area summary pages and there were also separate summary pages for the JFLEX and TAPS tools, which provide mission planning and effects evaluation. Further, the CJTF staff developed their own summary page that was intended to provide this sort of information to both the CINC/NCA and functional area component commanders. Comments made by the K-Wall users, however, reflect a perception that the K-Wall did not sufficiently support communication of mission goals and objectives. These comments include:

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

- It did not provide the commander's intent to me.
- The CJTF level did not feel comfortable . . . with no way to sync with higher and lower levels—no way to push information or convey needs/plans/intentions.
- When the component commanders let the CJTF know they were having trouble knowing what the CJTF wanted, it led to the development of a CJTF page.
- Need to define better what "Today," "Tomorrow," and "Long Range" mean. Some areas (e.g., Sea Control) used them better than others. Information requirements and CCIRs should be considered.
- Commander's priorities must be made clear to all. Shared awareness must include CCIRS/priorities etc., or it's not shared.
- The overall battle plan is not really reflected on the K-Wall. . . .

3.1.7. Content Requirement 4: Anchor Desk Output

Previous interviews indicated that K-Wall users needed to see output from anchor desks on the supplemental monitors of the K-Wall. Analysis of the screen captures revealed that information produced by the anchor desks from the 13 functional areas was the primary information presented on the peripheral monitors of the K-Wall. Figure 9 (top panel) shows the percentage of time that a summary page was displayed on the K-Wall displays. Even though many types information and tools were available to be displayed on the K-Wall, Figure 9 reveals that the summary pages were by far the most commonly displayed information products (86%, averaged across all monitors). The bottom panel shows the percentage of time that the summary pages from the individual functional areas were displayed on the K-Wall displays, averaged across monitors. As can be seen, all of the functional area summary pages were displayed on the K-Wall, although the amount of time that they were displayed varied across the different areas.

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

File Formats - All monitors

Figure 9. Top panel shows percentage of time that a summary page was displayed on the K-Wall displays, averaged across all monitors. Bottom panel shows percentage of time that a summary page from one of the 13 functional areas was displayed on the K-Wall, averaged across all monitors.

The K-Wall data logs also indicated that information products from these anchor desks were the most commonly accessed information on the K-Wall monitors. Figure 10 shows the number (per hour) of summary pages and other information products (i.e., links from the summary pages) produced by the functional areas that were accessed as a function of operational phase. As can be seen, over time, as the K-Wall users and information providers became more familiar with the technology, they accessed more K-Wall information products.

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Number of Information Products from the 13 Functional Areas Accessed
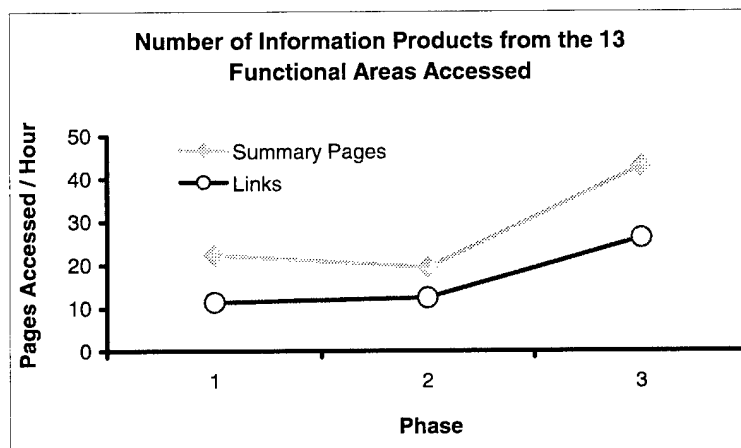
Figure 10. The number of summary pages and other information products (i.e., links) from the 13 functional areas that were accessed via the K-Wall, as a function of operational phase.

3.1.8. Content Requirement 5: Connectivity/Collaboration

During Global 2000, several collaboration tools were made available to players. The primary tool provided was InfoWorkSpace™ (IWS), a bundle of collaborative tools for communication and data access. K-Wall users who had access to IWS, however, tended to use their IWS on the laptops provided on the command table. The K-Wall did provide a dedicated VTC window (on a thirteenth monitor) but this was not used for this purpose. Comments that related to collaboration and connectivity during the game in general were:

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
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	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

- Groups that were on IWS did use chat for collaboration.
- There was a need for better shared awareness/collaboration.
- The VTC was worthless, actually negative because poor execution made it a distraction . . . maybe they thought they were sharing information but they weren't. It should only be used in certain situations.
- What made it work was the table, people around the table, verbal communication . . . great for passing information up and down . . . but I missed face to face and verbal communication from commanders to work . . . needed to get the headphones to work, the VTC to work.

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3.1.9. Content Requirement 6: Cognitive Support

The K-Wall itself did not provide integrated cognitive support tools. Therefore, most comments related to cognitive tools focused around the need for such tools on the K-Wall in general or on the summary pages themselves. These requirements for cognitive support are discussed in later sections (New K-Wall Tools and Summary Page tools).

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
	Connectivity/Collaboration
	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

The output (in the form of summary pages created for this purpose during the game) from a limited number of *nonintegrated* cognitive support tools could be displayed on the K-Wall. These tools were the:

- Theater Assessment Profiling System (TAPS), which provided effects-based assessment of the operational system.
- Joint Force Level Execution Monitoring and Re-planning Software (JFLEX), a mission planning and monitoring tool.
- Computer Aided Evaluation of System Architectures (CAESAR), a course of action visualization support tool (Levis, 2000).

When they were accessed, these tools or their outputs were most often displayed on one of the focus monitors of the K-Wall. Figure 11 shows the percentage of time that the output from one of these cognitive support tools was displayed on one of the K-Wall focus monitors.

Cognitive Tools Output Displayed in Focus Monitors

Percent of Time Displayed

Legend: □ PHASE1, ■ PHASE2, □ PHASE3

Tools: TAPS, JFLEX, CAESAR

Figure 11. The percent of time that output of the few cognitive tools was displayed on one of the K-Wall focus monitors.

As can be seen, K-Wall users rarely viewed the output of these tools—the most often accessed tool was TAPS, which was accessed only 3.6% of the time during the game (averaged across all three phases). Because output from the other tools (JFLEX and CAESAR) was so infrequently displayed

on the K-Wall, no user comments were observed that related to these tools. Comments related to the TAPS tools included:

- TAPS would be nice, if it's working. . . . Is TAPS updated on here?
- A common operational baseline should exist, a shared story. . . it could be TAPS at the NCA level.
- Great idea but information time-late and manpower intensive. It should be automated. Immature tool—useless now but maybe good some day.
- I don't know what this is telling me!
- This [TAPS] is a bean counter's tool.
- I don't trust it because I don't understand it.
- As executed in game, this is a very immature tool. Looks like it should have been good, but information inputted was from different people with different subjective opinions. If you don't know where you are going, any road will get you there. . . .
- No decision points, no triggers, no sense of progress—maybe it should be a decision aid. This is way ahead if its time.

Suggestions for several new K-Wall tools were made throughout the course of the game. Tools for the K-Wall in general that were requested were those that provided:

- *Alerting*—tools that allowed the K-Wall users to alert others about information and to be alerted about changes, especially in information not displayed on the K-Wall, were requested.
- *Attention management (pointers etc.)*—many requests were made to provide tools to direct K-Wall users' attention to relevant information, especially in the context of discussion/collaboration using the K-Wall.
- *Other tools*—included chat capability with information providers (e.g., Webcam32).

Related comments included:

- There have been lots of requests for the CJTF to have control of alerts—to be able to alert everyone else (i.e., push information to everyone else).
- The pages that aren't displayed on the K-Wall don't get looked at.
- [To collaborate. . .] We each need to have our own different colored pointers so we can talk about the same things together.
- You need the ability to have a pen or light you can use to draw on board from a distance . . . a mouse pointer/pencil device.
- Built-in chat with functional areas for summary pages would be useful.
- Webcam32 might be a tool for future use on the wall.

Content Requirements. The content of the K-Wall was identified as the key to its successful use by its users as evidenced by general comments that were overheard such as:

- Content and people make the K-Wall useful—without them, it is simply a bunch of monitors.
- Garbage in–garbage out.

As before, the K-Wall was designed to meet the content requirements that emerged from previous interviews with potential K-Wall users.

3.1.10. Feature Requirement 1: Flexible Configuration

The K-Wall provided flexibility in the configuration of the displays by allowing users to easily move the contents of the K-Wall monitors and bring up new information as necessary. The initial intent of the K-Wall design was that some monitors would be dedicated to presenting the same type of information and that others would be configurable, and could be changed as the context demanded. However, in practice, all the monitors were configurable and could display any information available to K-Wall users.

14 User Requirements			
General	Shared SA		
	Integrated Information		
Format	Intuitive Graphical Interface		
	Consistency		
Content	Tactical Focus		
	Supplemental Information		
	Mission goals and objectives		
	Anchor Desk Output		
	Connectivity/Collaboration		
	Cognitive Support		
Feature	Flexible Configuration		
	Drill-Down		
	Information Age and Reliability		
	Tactical Overlays		

The comments and behaviors of the K-Wall users reflected two contexts within which the need for configurable displays must be met. First, the K-Wall must be configurable to support a change in the operational situation. During Global 2000, K-Wall users were observed to reconfigure the K-Wall displays to meet this need. For example, they brought up different summary pages in the peripheral monitors following a change in operational phase.

Second, the configuration of the K-Wall must be flexible enough to meet the demands of different users. Much discussion revolved around this requirement for user-defined K-Wall configuration (see the discussion of Tailorable K-Walls in section 3.4.1) However, the fact that the K-Wall was used by only two groups (composed of the same individuals) during Global 2000 made it difficult to collect data relating to this requirement. At the NWC, the K-Wall was configured to meet the information requirements of the CJTF and JCC staff. However, the CINC *could have* configured the duplicate K-Wall aboard the *Coronado* differently for use. A comparison of the typical configurations of these two walls revealed that they were configured quite similarly (see discussion on K-Wall Usage on *Coronado*, section 3.4.3)—though the reasons for this are unclear.

Across Situations

- Now that we are no longer in [Phase 1] and in [Phase 2], I need to see information relevant to that . . . only certain pages.
- We need to replace that Overview with ground control
- At the beginning of Phase 2, the Overview page was no longer being displayed, and no one seemed to use it . . . later in Phase3, the Overview page was brought back up.
- The limitations were lack of flexibility in reconfiguring it. . . .

Across Users

- Whose tool is it? If three groups, CJTF, CINC, NCA, can see the K-Wall they need to see different information. . . . One K-Wall glove does not fit all—there needs to be tailorable information. . . .
- The big issue is who uses it. Information presented should differ. It should be tailored to specific users/user groups.

3.1.11. Feature Requirement 2: Drill-Down

The Web-based K-Wall application and the summary pages produced by the functional area information providers were designed to support drill-down to more detailed information. The intent of this design was to enable information providers to use the bulleted text of the summary pages (status alerts, alerts, impacts, links) as hyperlinks to other information products such as other Web pages, briefs, and other documents. As the game progressed and information providers became more adept at posting to the K-Wall and updating summary pages, the number of the links increased, content of these links became more detailed, and the relationship between linked products became more complex. This is reflected in the K-Wall data logs, which automatically recorded the path of every link accessed

General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
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	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

through the K-Wall application, from which can be extracted both the source and format of these links. Figure 12 shows the content and format of the pages accessed as functions of the operational phase of the game. As can be seen, the majority of these pages were Web pages, in html format.

Figure 12. The number of links accessed per hour of game play via the K-Wall as a function of format and operational phase.

Figure 13 shows the number of products (html pages, PowerPoint briefs, Word documents, etc.) that were produced by functional area information providers as a function of the operational phase. The top panel shows the number of summary pages that were accessed per hour. The lower panel shows the number and kinds of other products produced by the functional areas anchor desks (i.e., those that were not summary pages). These pages were those that were accessed via drill-down from the summary pages. As can be seen from these figures, a great deal of drill-down occurred—over 700 links were accessed over the course of the game ($\approx$40 hours of total game time). Although, as would be expected, the relative amount that information products from the different functional areas were accessed varied as a function of phase, the number of summary pages and links accessed across all the functional areas increased over time.

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Number of summary pages accessed as function of operational phase

Number of other information products (links) accessed as function of operational phase
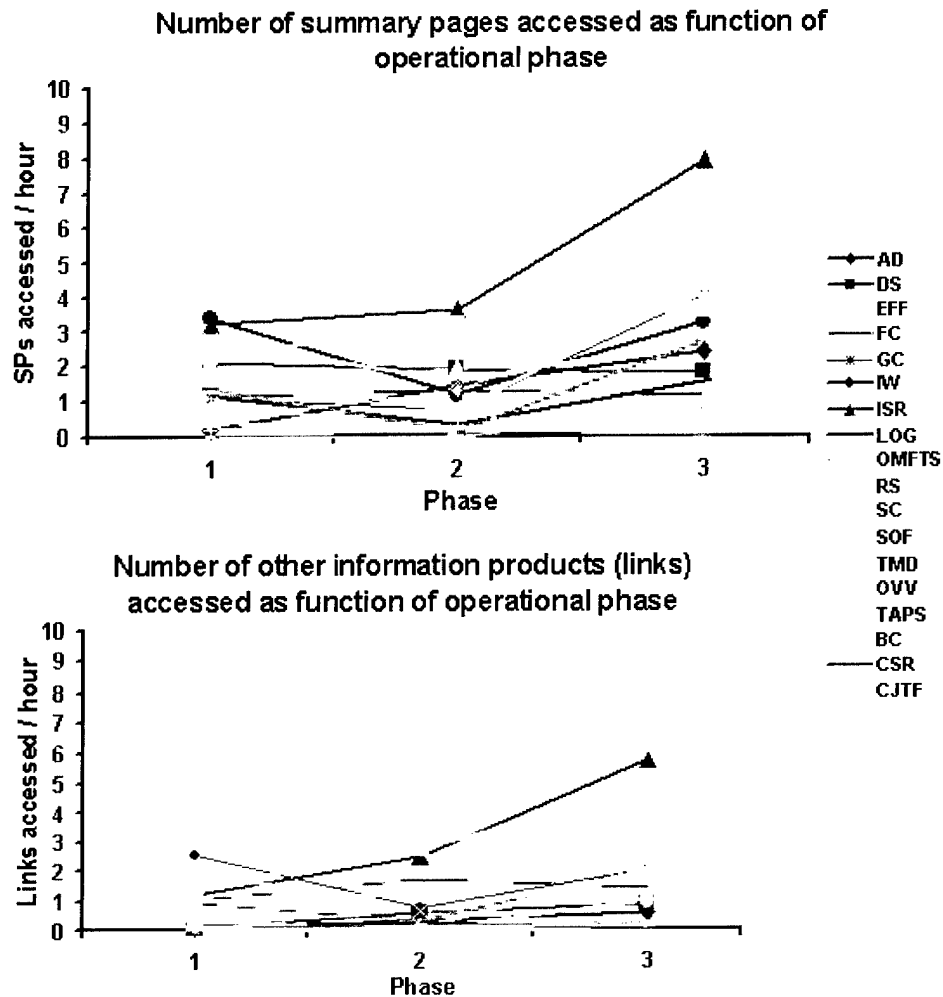
Figure 13. The number of functional area summary pages and information products accessed via the K-Wall as a function of operational phase of the game. (In addition to the information products from the 13 functional areas, data are shown for other summary pages: the Overview page (OVV), TAPS, Blue Comms (BC), CAESAR, CJTF).

Although a great deal of drill-down to access links from summary pages was observed, many of the comments made by K-Wall users reflected a need for improvement in the drill-down. Comments reflected concern that drill-down was not being supported or that the need to drill-down through too many levels to find information might prove inefficient. An important observation made by many of the K-Wall users was that source of information was not made apparent on the links. This is an important issue because it suggests that users have difficulty maintaining a mental representation or map of the "K-Wall information space" making it difficult to navigate through the different levels of linked information. Many comments were also made regarding what the content and format of linked information should be. More discussion related to this topic can be found in the Summary Page Links Content and Format sections below (sections 3.2.1 and 3.2.2). Representative comments included:

- There is a problem with too many links, I don't want to drill-down to say "mother may I".
- When I click on a red gumball there are no links . . . drill-down is not being supported.

- [*In a comment about how intuitive technology was*] We could view the functional area information, could drill down for more information.
- The problem is that pages/links don't indicate where they came from . . . need to include addresses or headings on links.
- Left side [information in focus monitor 9] is from . . .?

3.1.12. Feature Requirement 3: Information Age and Reliability

The K-Wall provided information age, in terms of the last update time of the summary page, using a simple time and date stamp. Early in the game, problems with the usefulness of this time stamp arose because the computer systems (from which the time stamps were generated) used by players were not all synchronized to show the same time. Some comments reflected that K-Wall users wanted a better indication of the age of information products presented on the K-Wall. More important, however, were comments suggesting that users were not happy with the *rate* at which the K-Wall was being displayed, an issue that will be discussed later (Summary Page Update), which is related to the age of the information on the K-Wall. Representative comments included:

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
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	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

- One thing we've heard about the K-Wall this week is "how current is the information?"
- [*Pointing out how long it takes to update page, and how this leads to outdated information to be displayed on the K-Wall.*] The problem is that it's not plugged into anything . . . it takes so long to update, throw on overlays, that it's old by the time it gets up there.
- A lot of these things don't have times on them so we don't know how old they are.
- It's been good when the guys are updating it.
- Currency of information is a big issue with the wall, in terms of:

  - how long to produce products
  - how to present/link/publish products

3.1.13. Feature Requirement 4: Tactical Overlays

The main tactical tool used on the K-Wall, C2PC, provided a number of overlays that were used frequently throughout the game. Further, users of TacGraph could show filtered (de-cluttered) representations and include objects such as arrows, shapes, etc., to graphically represent things such as projected movement, zones of interest, etc. Comments related to the TacGraph tool were made by both users of the K-Wall and the information providers. These comments suggested that both of these groups believed it to be a good tool for creating useful graphics to represent the operational picture. Information providers found the software easy to interact with to rapidly build effective graphics. The output of TacGraph is in html format and information providers took advantage of this,

14 User Requirements	
General	Shared SA
	Integrated Information
Format	Intuitive Graphical Interface
	Consistency
Content	Tactical Focus
	Supplemental Information
	Mission goals and objectives
	Anchor Desk Output
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	Cognitive Support
Feature	Flexible Configuration
	Drill-Down
	Information Age and Reliability
	Tactical Overlays

sometimes producing interactive graphics hyperlinked to multiple levels of drill-down. K-Wall users expressed the desire to see the TacGraph pictures linked to C2PC data. Representative comments related to C2PC and TacGraph included:

- Clearly tools like TacGraph are great for rapidly building a picture that can express info concisely and rapidly. . . .
- I believe this is a fantastic tool, which was brought too late in the game. Its graphics are outstanding and bandwidth is conserved when docs published in JPEG format.
- It [TacGraph] needs to be integrated with C2PC.
- They're not using TacGraph enough, they should because there's not a lot of space on page . . . a picture is better than words.
- SC summary graphic uses C2PC backdrop. What about using TacGraph or IMAT, since it can show more useful info.
- Players are actually trying to find the full capability of the systems. They are trying to import data from C2PC onto TacGraph. Both systems have good features that the other doesn't. They want real time data from C2PC on the TacGraph chart for manipulation.
- Those procedures for providing the "picture" need refining . . . need training, not on how to operate tool but how information can be presented . . . visualizing information. . . .
- C2PC isn't Web-based—which is a problem since everything else is.
- Bring up C2PC for situational awareness.

3.2. SUMMARY PAGES

The present section of the results is devoted to the analysis of the observational and automated data specifically related to the summary pages. A great deal of discussion focused around the content, layout, and format of the summary pages. This is not surprising since the summary pages were the most common format of the information displayed on the K-Wall and they served as entry points into the Knowledge Web of anchor desk information products. The current data collection effort attempted to evaluate the design of the summary pages and answer questions such as:

- Did the summary pages (and their links) have the right content?
- Did the summary pages (and their links) have the right format?
- How can the summary pages be improved?

3.2.1. Summary Page and Links Content

A great deal of discussion was focused around the content and features of the summary pages. The summary pages of two functional areas (ISR and Effects) changed the text of the alerts ("Today," "Tomorrow," "Long Range"), which had been intended to remain constant across summary page, to different text. However, most of the discussion related to how to define specific content, who should define it, and how to maintain consistency across summary pages. This suggests that, in general, the content categories (status, alerts, links, etc.) met the information requirements of the K-Wall users. The discussion of the content of the links pages suggested, not surprisingly, that the links should provide information directly related to the information on the summary page. For example, a link from the alert text for Today, should provide detail about today's status and indicate why the alert was the color it was. The need was also expressed to display a clear indication of the source of a link. Representative comments were:
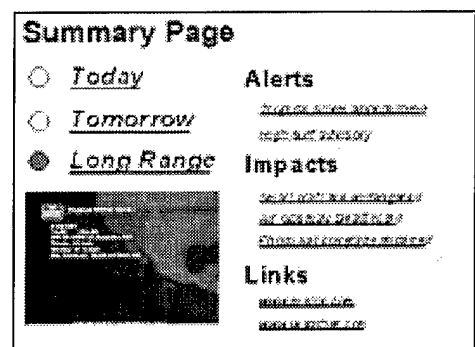
Summary Page

- An initial problem was: "what should be on . . . page?"
- It's important to communicate and have a common understanding of what should be on the wall.
- For ISR [summary page], instead of today, tomorrow, and long range, I want to see air, land, surface, subsurface with links to C2PC.
- *[Discussing CJTF page]* We need to include things like the commander's intent, Today (what we plan to do for next 10 days) . . . what's going on today, tomorrow, etc.
- We didn't ever define what today, tomorrow, long range was . . . Sea Control had a good method: Today equals what I'm going to do today, intentions, etc.
- *[Regarding status alerts]* We need to understand what each rule set is and how it is being used by each cell and document it for the CJTF and CINC. The rules can be different for each FA as long as the CINC and CJTF know the rules.
- That's what we want to see: what they're planning to do today, what are their intentions for tomorrow. . . .

Links

- When you hit a button, (today, tomorrow, long range) there should be an indication of what's going on.
- When there's a yellow or red alert, they should tell you what they're doing about it.
- When you change the color of the alert, we need to know why the alert changed.
- That's what we want to see: what they're planning to do today, what are their intentions for tomorrow. . . .
- [CJTF page] The CJTF should provide the CINC with a picture of what's going on so he can let others know. . . .
- [The text on a link from a yellow status alert included a description of why the text/alert was yellow] They should all do that!
- *It's a problem that pages/links don't indicate where they came from . . . need to include addresses or headings on links.*

New content areas. Although the summary pages from the 13 functional areas provided useful information to the K-Wall users, there were requests that other types of information be represented in the same format to be displayed on the K-Wall. During the course of the game, requests to provide such information led to the development and display of summary pages with the following content:

- CJTF—this was developed and updated by the CJTF staff (BWCs, with guidance from the senior staff) and was originally discussed as a means of passing CJTF intent to junior staff but evolved as a means of updating more senior players (CINC and NCA). Once implemented, much discussion focused around the content of the information to provide on the summary page and link to.
- *Communications* (Blue Comms)—this included information related to local (NWC) communication status, as well as that the communication capability related to the game.
- Other tools that were displayed on the K-Wall—CAESAR, TAPS, JFLEX.

The development of such pages allowed information from these sources to be integrated with the K-Wall in a consistent manner, and provided users with the same features that the functional area summary pages did (drill-down, consistent format etc.). Other information that was requested and, when available, displayed on the K-Wall was that related to:

- METOC (requested and displayed)
- *Blue's Red Cell* information (requested)
- *A searchable reference library*—maps, ROEs, capabilities, etc. (requested)

3.2.2. Summary Page and Links Format

The most prevalent suggestion with respect to the summary page format was to dedicate more room to graphical information and less room to text information. This represents both the acknowledgement of the usefulness in representing information in a graphical format as well as the difficulty in reading the text on the summary pages (see Visibility discussion below, section 3.3.2). The comments relating to the format of the links from the summary pages reflected the same acknowledgement and stressed the need to "keep it simple." K-Wall users explicitly requested that graphics be used as much as possible and when not possible, simple, large black and white text be presented. Comments relating to the format of summary pages and links include:
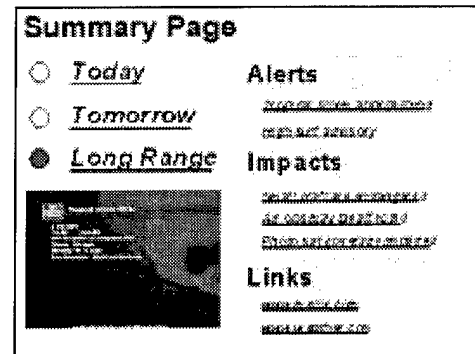
Summary Page

- Suggested changing the summary page layout so that the entire page is a picture with small window of alerts/links in corner.
- There's too little room on the summary page.

Links

- When graphics link to PowerPoint slides, use simple text, no logos, no pictures, use black and white text . . . the links are just [too] full of stuff.
- . . . too much data, need simple PowerPoint slide.
- We need standards of use (e.g., colors used, processes completed, level of detail, purposes, etc.).
- You need to put the most important information on the first slide.
- If they put a lot of text on it, I just skip right over it [*when monitoring the new links*]. The information needs to be condensed.
- Keep things simple, use big bullets. . . .
- A business rule should be: don't use too many acronyms because not everyone understands them.
- Italicized text on the link is hard to read.
- Yellow text. . . . hard to read on white background.
- If a whole page of text was on the K-Wall, we didn't even read it.
- Too much detail . . . if you had a picture showing the same thing, that would be great [*list in Word doc, small font*].
- They are not using TacGraph enough, they should, because there's not a lot of space on a page . . . a graphic would have told ten thousand words.

3.2.3. Summary Page Update

Even with the right content and format, the summary pages are not useful unless they are updated at an adequate rate to reflect events and changes in the operational situation. Early in the game, user comments suggested that the K-Wall users believed that the summary pages were not being updated at a sufficient rate. However, this perception appeared to wane as the game progressed and the producers of the summary pages became more proficient at creating summary pages and links. Examples of these comments are:

- Some of the dots have changed color but they still don't have links associated with them.
- Is the game paused? Why is nothing updating?
- *And later in the game* . . . The game is progressing smoothly . . . the K-Wall is getting updated regularly.
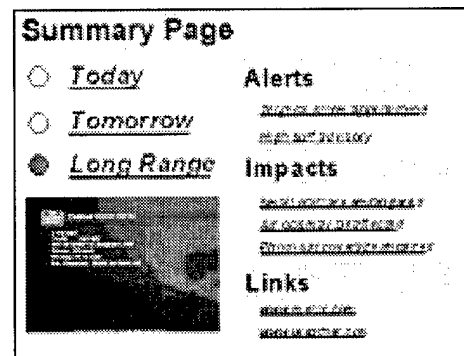
An indication of whether the summary pages conveyed the "right" information to users, as well as how well the summary pages were being updated, comes from an examination of whether the contents of the K-Wall reflected the important events of the game. For Global 2000, information providers (many times the same ones that updated the K-Wall summary pages), game personnel, and others provided information about game developments by posting to the Sitsum file located within WIGS. This document was essentially a list of text describing events, the time of each event and the source of this information (i.e., who posted the event to the Sitsum). It was ordered according to the time that items were posted, and it consisted of hundreds of postings every day.

The K-Wall users could access the Sitsum (via WIGS on the K-Wall), to become notified about the most recent game events—i.e., they could pull information from WIGS. This often involved scrolling down to read items that had been posted more than a few minutes before the current time. However, if the K-Wall summary pages were being updated at a sufficient rate, the most important of these events should also be reflected in the K-Wall content—i.e., information providers should be pushing information to the K-Wall via the summary pages. An analysis was conducted that compared the percentage of time that important events were communicated on the K-Wall in these two ways based on information from the screen captures of the K-Wall (which were recorded every 5 minutes) and the Sitsums. The Sitsums and the critical event logs from each day of the game were examined by a Subject Matter Expert (SME), who identified 37 of the most important developments during the game. Another SME assigned a "criticality" rating to these events, (1 = critical event, 2 = significant event, 3 = important event, 4 = event of interest.) The screen captures recorded before and after these events were then examined to determine if the contents of the K-Wall gave an indication of them (on the summary pages or links, on the Sitsum displayed on the K-Wall, or via some other means, such as e-mail). Over 70% of the important events were reflected in the screen captures of the K-Wall in at least one format and 32% of them were indicated on both the Sitsum and on a summary page/link.[4] The mean percentage of time that these events were reflected on the K-Wall, as a function of criticality and format is shown in Figure 14 and the amount of time it took for the events to be reflected (in minutes, after the event was posted to the Sitsum) is shown in Figure 15.

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[4] Because the screen captures were recorded every 5 minutes, these numbers are likely underestimates of the actual percent of time that the important events were reflected on the K-Wall.
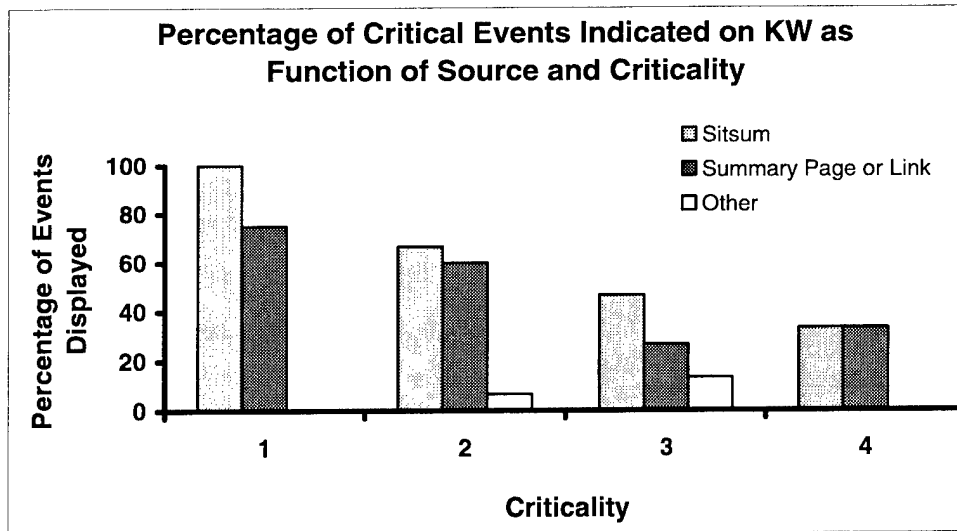
Figure 14. The percentage of critical events displayed on the K-Wall as a function of the format source of the information and the criticality of the event (1 = critical event, 2 = significant event, 3 = important event, 4 = event of interest).
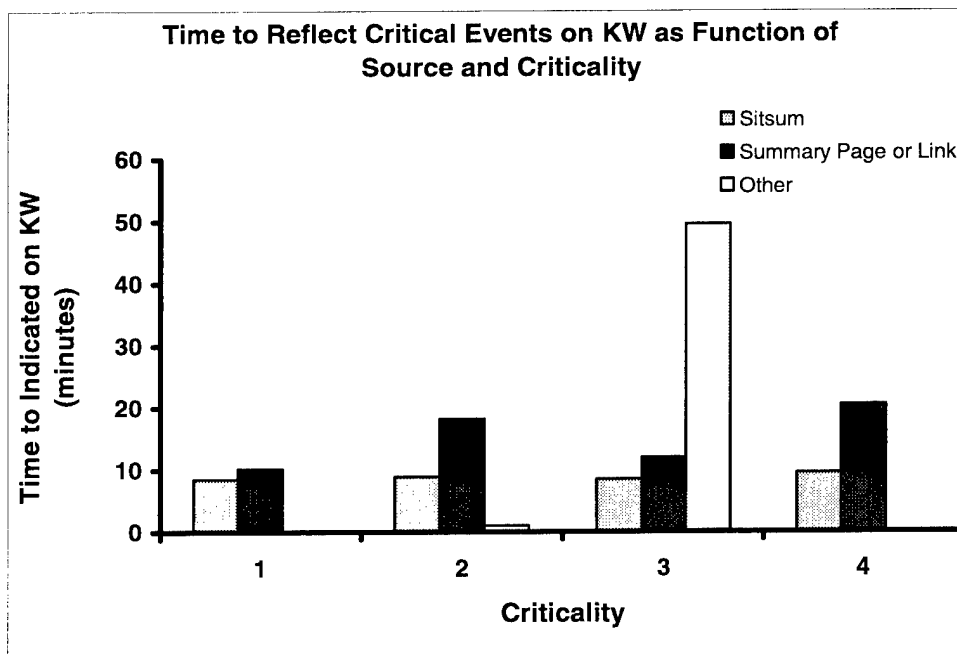
Figure 15. The average amount of time it took for critical events to be displayed on the K-Wall as a function of the format source of the information and the criticality of the event (1 = critical event, 2 = significant event, 3 = important event, 4 = event of interest).

As expected, more important events were more likely to be displayed on the K-Wall (100% for critical events, 73% for significant events, 67 % for important events, and 33% for events of interest). However, when they were displayed, the time it took to be displayed in one format on the K-Wall did

not differ as a function of criticality (8.5 minutes, 8 minutes, 10.7 minutes, and 9.5 minutes on average). Important events were displayed on the Sitsums 59% of the time after 8.7 minutes vs. 37 % of the time after 15.8 minutes on a summary page or link. This result suggests that pulling information from the Sitsums was a faster and more reliable way of becoming informed about critical events than relying on the K-Wall summary pages to provide this information.

3.2.4. Summary Page Tools

Alerting Change to Summary Pages

One of the most prevalent needs that emerged from the observational data was for tools that alerted the user to changes to the summary pages. K-Wall users had great difficulty detecting when changes occurred to information on the summary pages and, when they did, determining specifically what information changed and how important the change was. The need for a change alerting system was underscored by the many "fixes" that were improvised and implemented to alleviate this problem. Because the summary pages were not originally designed to provide a mechanism for alerting change to K-Wall users, the wall users and information producers introduced business rules and took advantage of the coding used by html to indicate "visited" links to help them become apprised of changed information. The specific fixes observed during Global 2000 were:
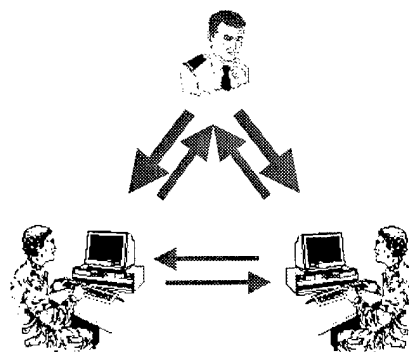
- The KMs introduced a business rule early in the game, requiring that information providers include an asterisk to a new link and that the BWCs inform (via e-mail) these information providers when the link was read by the K-Wall users (this also relates to the feedback issue discussed below). The information providers were also required to put an exclamation point next to hyperlinks that they believed needed to be addressed immediately. These business rules were effective in alerting the K-Wall users to changed information, but the rules were only adopted by some of the information providers and appeared to fall into disuse later in the game.
- The operator of the K-Wall typically looked for the standard html color change (from purple to blue, and vice versa) in text-based hyperlinks to determine whether a link had been accessed. A problem with this method was that many times information providers made changes to the underlying documents that were being linked to and not to the summary pages themselves. [This type of change does not cause a hyperlink to change color; hence it led to some confusion.]
- Information providers sent change notifications (i.e., when a change was made to the summary pages) to the BWC and other K-Wall users via e-mail, chat windows, phone calls, or by walking up to the JCC and informing them.
- Information providers used the designated graphic area on the summary page as an alert window (e.g., using the text "alert").

Comments and observations relating to this need for alerting change included:

- Change the stop lights so they flash when changed, like the gauges on WIGS.
- There are problems . . . with automatic alerts and things like that. . . .
- When they update their page they need to update their links [*problem with new links not being blue*].

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- ... there isn't anything flashing to let me know it's changed.
- On the K-Wall, the overview stoplight graph does not automatically reflect the status of the various summary slides when they are updated.
- I'm looking for blue text as an indication of new information. ...
- When I'm looking for pages, I don't use the overview slide ... I look for blue links and asterisks.

Feedback to Information Providers

Also emerging as a needed tool for K-Wall users, is one that would enable them to inform information providers that a particular page or link had been accessed, and convey their information needs. This tool would clearly benefit the information pushers since they would know when their information had been viewed, and their comments reflected this need. Providing this type of feedback might also improve the update rate of the K-Wall since the information providers would become more aware of how often their products were being used. The CJTF summary page that was developed during Global 2000 was one means to convey the information needs of the K-Wall users to the information providers; however, there was no tool available that indicated to the information providers what the K-Wall users had looked at or drilled down to using the K-Wall. Comments reflecting the need for this tool were:

- We need a way for K-Wall users to convey desires/disseminate information "down" to anchor desks and lower echelons.
- [*Information provider in the same room as JCC*] I have an advantage over people downstairs because I can walk over and see if they've looked at my links or not [*using color of link text*].
- Give the admirals a "laser" and check boxes that they can check once they've read something.
- There needs to be automatic feedback that the page has been read.
- There needs to be a feedback loop on K-Wall from BWC to AD/FA.
- Feedback notification is required when something urgent has been received by the CJTF.
- I recommend that the signal be cleared once the commander views the status.

3.3. K-WALL USAGE AND USABILITY

An important objective of the Global 2000 K-Wall data collection effort was to examine how the K-Wall was used during a realistic operation and to identify any usability issues related to its use and operation. This section of the results discusses the observed usage of the K-Wall, including usage context (how and when the JCC staff used the K-Wall) and operation (methods employed by the K-Wall operator) and identifies several problems related to the K-Wall usability and visibility.

3.3.1. Usage Context: When and How

The K-Wall was used in a variety of contexts during Global 2000. The most common way in which it was used was as a "situation assessment" tool. JCC staff (and others) continuously viewed the K-Wall throughout the game to maintain SA and to discuss information with each other. Many user comments reflected this and also highlighted its importance in eliminating the need for these personnel to be briefed daily by the component commanders. The K-Wall was also used as a briefing tool, especially during the transition between operational phases of the game. Observations and example user comments included:
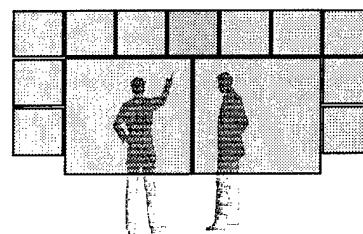
- The K-Wall was used for briefing, discussion of information without having to stop the war.
- We didn't do a briefing at 8 o'clock, 1 o'clock . . . we didn't need to be brought up to date because we were always up to date . . . we didn't have to go off for 2 hours and prepare a brief.
- The K-Wall was used as a "situation assessment tool," continuously viewed by JCC staff.
- The K-Wall was used as briefing tool by component commanders to individual or groups of JCC staff.
- . . . a good tool to transition in and out of briefing and for [assessment].
- *The K-Wall was used to review information to put on the CJTF page.*

3.3.2. Visibility and the K-Wall

Many user comments concerned the difficulty that K-Wall users had in seeing information on the K-Wall. These comments primarily reflected problems in reading the text and small objects and controls displayed on the smaller peripheral monitors. This difficulty was also reflected by the fact that the K-Wall operator typically brought information from the peripheral monitors into focus on one of the central monitors in order to read it. However, even the information on the focus monitors was sometimes found to be difficult to read when it was too small or when other K-Wall users were obscuring the view of the monitors. Representative comments related to the K-Wall visibility included:
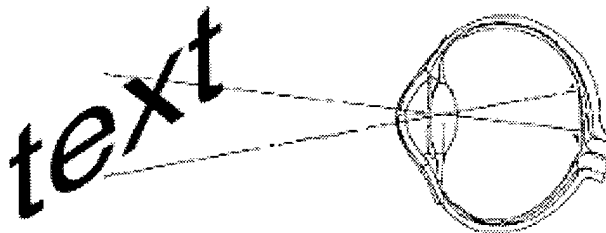
- It's hard to see items in pull down menus when you're trying to bring up a new summary page [in monitor 11].
- Here's another part of the K-Wall: you've got to have good eyes.
- The K-Wall operator frequently walked up to monitor 9 and 10 to read them.
- K-Wall users occasionally printed pictures to look at them (more common on Coronado).
- He [the CJTF] couldn't see the Strike page so he brought it up on his laptop.
- Whenever I say, "hey COS look at this on the wall," he has to get out his glasses.
- Can you see that tab? [on bottom of Excel page on M9, other BWC's head blocking his view].
- With all the monitors, needing to focus eyes is a problem. If people have a headache they can't make decisions.
- Many of the monitors are too far away to be seen easily in JCC.

In order to assess the difficulty in viewing information on the summary pages on the small peripheral K-Wall monitors, a "vision test" using the summary page format was conducted. Three observers with normal vision (unaided or corrected to 20/20) were presented summary pages that had the same layout and format as those displayed on the K-Wall during Global 2000, but that had been populated with random text. An example stimulus is shown in Figure 16. They were asked to identify all of the text characters displayed on the page. Accuracy at identifying the text was measured when the observers were seated at each of four positions on the JCC command table (positions A-D, see Figure 16), for summary pages that were displayed at the most central monitor (Monitor 4) and furthest (with respect to the four positions) monitor (Monitor 1).
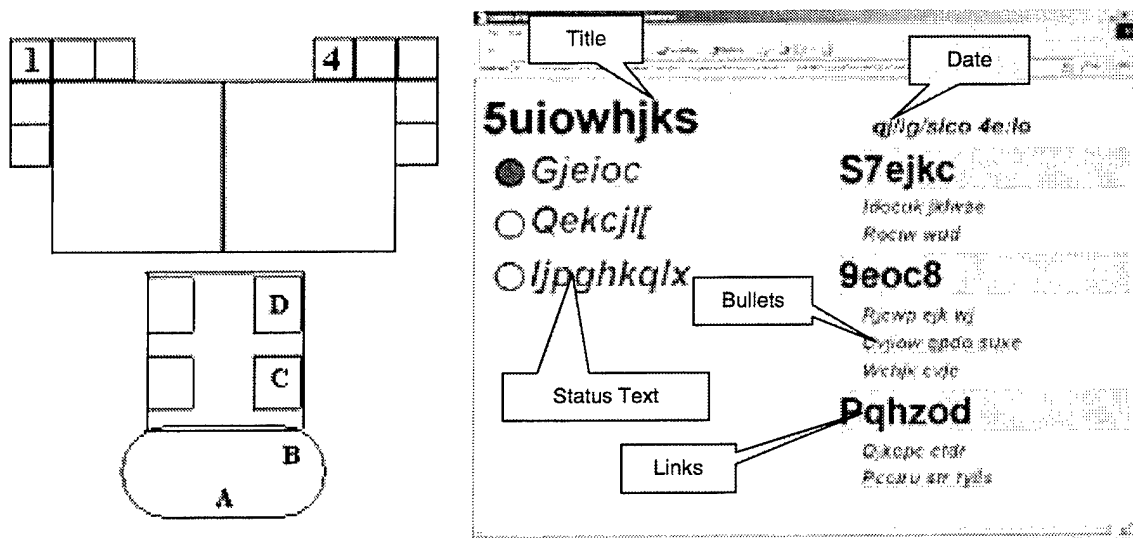
Figure 16. Left: The positions (A, B, C, D) from which measurements were taken and the monitors (1, 4) on which stimuli were presented for the "vision tests." Right: Example summary page stimulus used in vision tests.

Identification accuracy, averaged across all observers, as a function of distance and viewing angles for each of the four viewing positions is given in Table 2. As is shown, perfect identification of all the characters was only approached when a summary page was displayed on Monitor 4. Viewers had much more difficulty reading the summary page text on Monitor 1, especially at smaller viewing angles.

Table 2. Mean percent correct for identification of characters on vision test stimuli when seated at the four command table positions.

Position	Distance (inches)	Angle (degrees)	Percent identified	
			Monitor 1	Monitor 4
A	147	90	92	95
B	137	70	77	98
C	98	61	85	98
D	69	52	81	100

Table 3 gives the same data, broken down by text size and collapsed across viewing positions. Identification accuracy for the time and date and the bulleted alerts, impacts, and links (level 5) was very low when the page was presented on Monitor 1. This has important implications because this is the text of the hyperlinks to the alerts, impacts, and links pages, which were updated and accessed very frequently.

Table 3. Mean percent correct for identification of characters on vision test stimuli for the different summary page text sizes.

Text	Font Size	Percent identified	
		Monitor 1	Monitor 4
1 (title)	48 point	97	99
2 (status text)	40 point	97	100
3 ("alerts," "impacts," "links")	40 point	100	100
4 (date)	24 point	70	99
5 (bullets)	20 point	61	92

The above data corroborate the comments and behaviors of the K-Wall users that were observed and suggest that visibility was problem with the K-Wall during Global 2000.

3.3.3. Use of K-Wall Operations

The K-Wall application provided several operations that allowed users to configure and reconfigure the K-Wall content, update information, and run other tools in conjunction with the K-Wall. The menu bar (see Figure 17) on each window included controls common to Web browsers (Back, Forward, Refresh, and Home buttons, an address bar, a menu of favorite Channels/Functional Area Summary Pages), and buttons that allowed peripheral monitors to be brought into focus in one of the two central displays (Focus Left (9) and Focus Right (10)). A control menu (see Figure 18), accessible via a button on each window, allowed users to hide or show underlying applications (e.g., C2PC, Outlook, Word, etc.) and gave users access to four preset configurations of the windows. The four presets were:
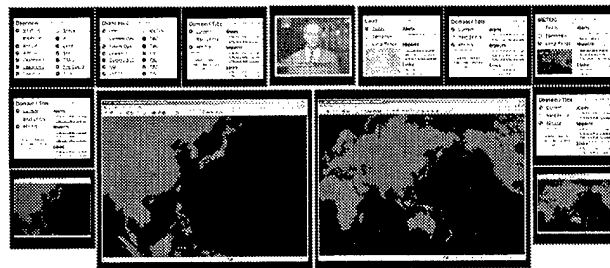
1. all windows shown except 9 (left focus window) and 10 (right focus),
2. all windows shown except 8 (bottom left windows) and 9,
3. all windows shown except 10 and 11 (bottom right windows),
4. all windows shown except 8, 9, 10, and 11 (all lower windows).

The purpose of these presets was to support the display of tactical information in multiple K-Wall displays, at least one of which was a focus window.
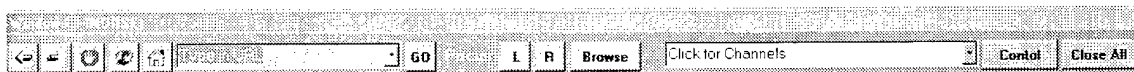
Figure 17. The K-Wall menu bar.
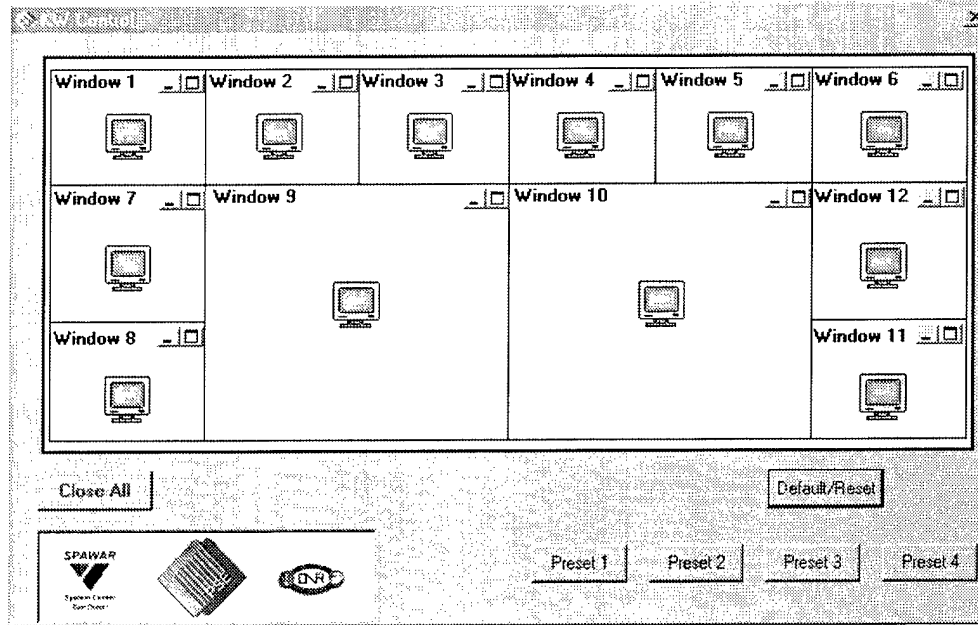
Figure 18. The K-Wall control menu.

The usage of a subset of these operations (Home, Refresh, Focus 9, Focus 10, Hide, Show, Presets) was included as information in the data logs. Figure 19 shows the number of these K-Wall operations performed per hour as a function of operational phase.
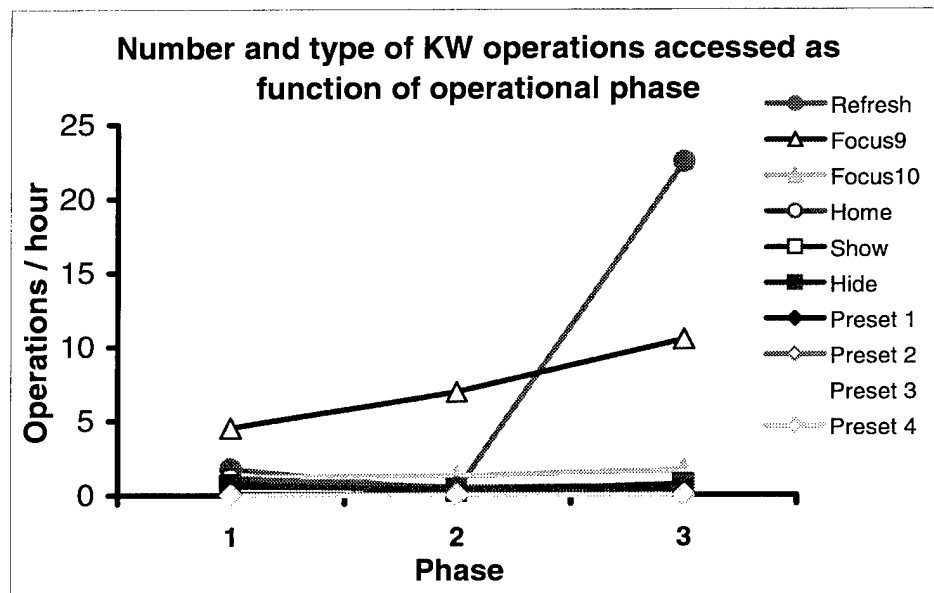
Figure 19. The K-Wall operations performed.

As can be seen, the most commonly performed operations were Focus 9 and Focus 10 and Refresh. The use of the focus operations reflects the observed behavior of bringing information from the smaller peripheral monitors into focus so it could be examined in more detail. This behavior increased over time. The increase in the number of refreshes was most likely related to the fact that,

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late in the game, the rate that the K-Wall was automatically refreshed was changed from once every 1 minute to once every 5 minutes[5]. The other K-Wall operations were performed less often. The hide, show, and home functions were rarely used, and the presets were almost never taken advantage of. This latter finding is probably due to the fact that preset 1 (all windows shown except 9 and 10) was the default configuration that was selected when the K-Wall software was started each morning of the game. This setting allowed for C2PC to be displayed in the two focus monitors, which more than adequately met the requirement for the K-Wall to provide a tactical focus (see the discussion of user requirements, above).

3.3.4. Evolution of K-Wall Operation/Control

The operation and control of the operation of the K-Wall changed over the course of the game as K-Wall users and potential operators became more familiar with it. Prior to game start and for the first several hours of game play, the K-Wall operation was primarily conducted by one of the K-Wall designers/technology support staff. At this stage, wall operation was largely directed by the BWC, with some direction coming from the rest of the CJTF staff. Early into the game, however, the BWC increasingly took direct control of the wall. As part of his role as BWC, he assumed responsibility for looking for changes in the peripheral monitors, managing the information displayed on the wall, moving the information from the small monitors into focus on one of the large displays, and drawing the attention of the CJTF staff to important changes and information. Mid-game (several days into game play), other CJTF support personnel began to operate the wall and became more proactive with regard to controlling the contents of the K-Wall. Comments made during and following the game reflected acknowledgement by wall users of the importance of a K-Wall operator who was both skilled at using the technology *and* who had enough operational knowledge to manage wall content effectively:
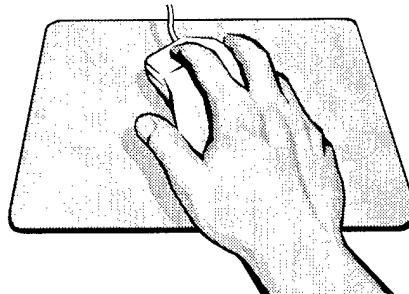
- [CJTF to K-Wall operator, BWC] You should notice when changes occur and bring it up on the wall.
- Sometimes they [CJTF et al.] ask me to bring stuff up on the wall.
- There was an evolution from them looking for information to bring up on the wall to seniors requesting information that they knew was there.
- Knowing what and where information is located (and that it exists) is vital to making the wall useful.
- The K-Wall operator evolved into a Knowledge Warrior. . . .
- In order for the K-Wall to be successful, there must be a person dedicated to operating it.

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[5] The change in the refresh rate was due to a business rule imposed during the game in an attempt to limit demands on available bandwidth.

3.3.5. Usability Problems, Ease of Use

Although, in general, the K-Wall operators and viewers found the K-Wall easy to use, several usage problems were identified based on observed behaviors and comments. K-Wall operators complained that accessing information that was found in locations other than the displayed summary pages or their links was difficult because it involved many steps. This usually required navigating to that information via the WIGS system or via the K-Wall channels menu (see Use of K-Wall Operation above, section 3.3.3). The fact that input to the K-Wall came from two sets of mouse and keyboard controls plus the touch screens caused some confusion when more than one person attempted to operate the K-Wall simultaneously. Confusion also arose because only the focus monitors had touch screens. Users were observed attempting to use the screens of the peripheral monitors as if they were touch screen-capable. Another commonly observed problem was the tendency for K-Wall users to lose the mouse cursor in so much screen real estate—especially after looking away from, and then returning their view to the display. Certain design features of the K-Wall were intended to prevent this problem; users were provided with both a specially-enlarged cursor and a hot-key combination that highlighted the cursor position on the display. K-Wall users however, still experienced some problems finding the mouse cursor. Comments relating to K-Wall usability issues included:

- With less than 2 weeks of use, the team was able to efficiently use the K-Wall.
- Where's my mouse? [wiggling the mouse to find the cursor]
- It was found to be useful by most users. . . .
- Navigating using the channel menu is inconvenient. For example, getting to WIGS involves many steps.

3.3.6. Preference and Comparison to Other Tools

In general, K-Wall user comments suggest that they liked the K-Wall, though users believed that there were problems that needed to be addressed and various improvements that could be made to its design. When comparing the K-Wall to the tools they currently had available to them, they expressed a preference for the K-Wall. Representative comments were:
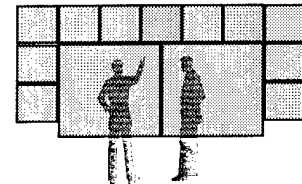
- This is much better than what we had before, better than a stickpin in a map. . . .
- The K-Wall was a hit. . . .
- It's a great information filter, but there are problems. . . .
- [Issue of defining what alerts mean] wouldn't be important if they didn't like the K-Wall, but that's what they're using.
- [*Discussing Global 2000 in general*] We're just light years ahead of last year . . . but each year *should* get better.
- [The K-Wall] is a good idea but it needs some tweaking. . . .
- The CINC had more negative comments . . . [CINC was located aboard *Coronado.*]
- [*From AD perspective*] . . . as people got used to the tools, then there was more use, more "let's put this on the wall". . . .
- The K-Wall was a good first step. . . .
- Life would have been miserable if I didn't have this. . . .
- It's a great tool you've got here, don't get me wrong. . . .

3.4. OTHER EMERGING THEMES

Although the current data collection effort was narrowly focused in scope, intending to answer questions related to K-Wall information requirements and usability issues, the observational data also provided important insights to several Knowledge Wall- and Knowledge Web-related issues. These other categories of data are discussed briefly below. In particular they concern questions regarding:

- How flexible/tailorable should the Knowledge Wall and Summary Page content be (with respect to different users) and who should have access to them?

- How flexible/tailorable should the Knowledge Web format and content be (with respect to different users)?

- What issues are related to the production and update of summary pages (from the perspective of information providers)?

- How was the K-Wall on *Coronado* used and what usability or other issues were related to it?

3.4.1. K-Wall and K-Wall Summary Page Access and Tailorable K-Walls

During Global 2000, the information providers in the 13 functional areas created summary pages with the intent that they would be displayed on the CJTF K-Wall in the JCC. Therefore, these summary pages contained content and links to meet the specific needs of the CJTF. However, an additional K-Wall existed on *Coronado*. Although, the users of this K-Wall were the CINC staff, the same summary pages were available and frequently displayed here. No summary pages were created to specifically meet the information requirements of the CINC (one exception to this was the CJTF page, which was intended to provide a means of pushing information from the CJTF up to the CINC and NCA). In addition, the summary pages were available to *all* Global 2000 players—they could be accessed, via the WIGS system, on any player's console. This allowed information to be shared easily across the different functional areas.

Comments made by the K-Wall users, information providers and others, such as the CINC and NCA staffs, suggested that there were both benefits and costs associated with this accessibility of information. On the one hand, the information providers, especially, found it useful to be able to view the information being posted by other functional areas to become apprised of the operational situation. They frequently provided links from their own summary pages to information produced by others. Many comments also reflected the desire of the information providers to have access to the CJTF K-Wall itself (or a window into it), in order both to access the information from other functional areas and to see what the CJTF was looking at.

On the other hand, although there was agreement that others, such as the CINC, should have their own K-Wall, the way in which this was implemented during Global 2000 fell short of players' expectations. This perception stemmed from the fact that the summary page information available to be displayed on the CINC K-Wall had been created for the CJTF and was insufficient (and inappropriate) to meet the requirements of the CINC. As one user stated: "One K-Wall glove does not fit all." A great deal of discussion centered around the idea of making K-Wall and its content tailorable, to fit the needs of its specific users. Representative comments included:

Access to Summary Pages

- Another important feature is that you can call pages up on other machines.

- We [MARFOR] checked the other pages periodically.

Access to a K-Wall

1. Functional area personnel

    - *Several cell personnel (in the same room as JCC) have come up to ask where the ISR picture (that they can see on the K-Wall) is located.*

    - Lower echelons need some way to tell what is currently being displayed on the K-Wall.

    - There are questions on whether the large screen displays on the sides of JOC can be slaved to show what the head table is viewing up close on the K-Wall? Since the K-Wall was only viewable from JCC, I don't believe the K-Wall was of much value [to the cells].

2. CINC/NCA

    - *There was concern expressed by the JCC staff that the CINC isn't seeing everything they can. . . . the same concern was expressed by the CINC.*

3. Tailorability of the K-Wall

    - Whose tool is it? If three groups, CJTF, CINC, NCA, can see the K-Wall they need to see different information . . . One K-Wall glove does not fit all—there needs to be tailorable information. . . .

    - Do we give everyone access to all the K-Wall and hope they access only the information they should or restrict access?

    - The CINC/NCA should have customizable version of the K-Wall.

3.4.2. Issues Related to Generating and Updating the Summary pages

The requirement to create and maintain summary pages was perceived initially as a burden by some information providers. The task of continuously providing updates to senior staff via the K-Wall was viewed as manpower intensive and time consuming, requiring at least a single individual to be dedicated to performing it for a significant proportion of the time.

However, this was offset by the fact that many information providers also felt that updating the summary pages was less demanding than the tasks that they would typically have had to do to prepare for the daily briefings to seniors. Information providers, by and large, provided links from the summary pages to information products that they were already producing, allowing them to perform this task concurrently with others and eliminating the need to dedicate hours of time to preparing for the briefing. Comments related to this, which were made by information providers and others, occurred later in the game, after they had become more familiar with the SumMaker tool provided to create and update the summary pages. This suggests that part of the burden initially perceived by information providers in updating seniors was related to unfamiliarity with the change in operations (i.e., the cancellation of traditional daily briefs), and the requirement to learn new software (i.e., the SumMaker software). Representative comments included:

- If you really wanted to do this right, you'd have to have someone updating the pages full time.

- It was a burden for echelons—but more so than preparing the daily brief? Some thought it was, others did not! More so in first week, as people got used to the tools, then there was more use, more "let's put this on the wall."

- The use of the K-Wall is manpower-intensive in that many people were involved in its use— and the preparation of the content.

- Updating the K-Wall was a burden in the beginning. Bottom line: for a nearly real time K-Wall, a dedicated person must be there. If not, the K-Wall will be populated when the AD can get to it. It will be populated with information that is not timely, but a placeholder that appeases higher ups and looks good.

- Well-manned missions areas are being updated faster than poorly manned ones.

3.4.3. K-Wall Usage on *Coronado*

Although the current data collection effort focused primarily on the K-Wall at the NWC, there was also opportunity to collect data on the usage of the K-Wall in the Crisis Action Center (CAC) onboard *Coronado*. Data were collected over a number of days during the Global 2000 game. Data collected, and discussed below, included observations that related to K-Wall configuration and usage and comments related to problems encountered by K-Wall users.

Operators of the K-Wall on *Coronado* had access to the same files and most of the same tools that were available at the NWC. Just as the K-Wall in the NWC JCC could be configured for usage by the CJTF, the K-Wall aboard *Coronado* could be flexibly configured to show information required by the CINC. Nonetheless, the two K-Walls were configured in very similar ways (i.e., with tactical information in the focus monitors and summary pages in the supplemental monitors). An important difference found between the CINC's K-Wall and the CJTF's K-Wall was that the *CJTF summary page* was displayed in the lower left peripheral monitor aboard *Coronado*. This is a significant observation because it demonstrates that the CJTF page was being used as it was intended, i.e., to push information to the CINC.

There were also many similarities in the usage and operation of the two K-Walls. In each case, the K-Wall was used for situation assessment and briefing and it was generally controlled by a single, dedicated operator. Problems identified in user comments associated with the CINC K-Wall were those related to the alerting of changed information on the summary pages, the visibility of the information on the K-Wall and in the time lag associated with drill down (due to the fact that information had to be pulled from the NWC across a network). As discussed above (see Tailorable K-Walls), the CINC personnel did not believe that contents of the K-Wall, particularly the implementation of the color coding of the status alerts, was appropriate or correct for the CINC. This was to be somewhat expected since the summary pages had been created to meet the needs of the CJTF.

4. SUMMARY AND DISCUSSION

The current data collection effort had several objectives:

- assess whether the K-Wall sufficiently met the user requirements identified previously,

- determine whether there were new requirements,

- establish usage patterns,

- determine whether there were usability and usage issues that need to be addressed.

The following discussion summarizes the results and suggests future directions for K-Wall research and development.

4.1. HOW WELL WERE THE 14 INITIAL REQUIREMENTS MET?

The initial implementation of the K-Wall was intended to address the 14 requirements identified by previous interviews with potential K-Wall users (Smallman et al., 2001). The K-Wall was generally considered to be a success in terms of meeting—at least to some reasonable extent—the 14 identified requirements. This assessment is borne out in both user comments and in the results of the data analysis. Of course, certain characteristics of the wall were judged more successful than others. In general, both the automated and observational data suggest that the K-Wall was "a good first step." A summary of the 14 user requirements, the K-Wall design capability intended to meet them and an evaluation of whether or not the K-Wall met each design requirement is given in Table 4.

Table 4. How the results bear on the success (or failure) of meeting the 14 user requirements with the prototype K-Wall design.

User Requirement		K-Wall prototype design capability	Requirement met?
General	Shared SA	Shared display	√
	Integrated Information	Co-located summary pages	~
Format	Intuitive Graphical Interface	Graphical presentation when possible	√
	Consistency	Consistent format summary pages	√
Content	Tactical Focus	Ability to view multiple tactical displays	√
	Supplemental Information	Summary pages on peripheral displays	√
	Mission goals and objectives	Text document	~
	Anchor Desk Output	Summary pages with links to more info	√
	Connectivity/Collaboration	Collaboration tools (IWS)	~
	Cognitive Support	Limited output from nonintegrated cognitive support tools	~
Feature	Flexible Configuration	Any pages viewable in any display	√/~
	Drill-Down	Multiple scalable views, links to more info	√
	Information Age and Reliability	-	~
	Tactical Overlays	Various software for tactical graphic presentation	√

The co-location on a common display of a set of consistently formatted summary pages that were continuously updated led to a feeling among senior staff of improved SA and a reduced need for them to continuously interrogate junior staff for information. The K-Wall provided a tactical focus, when necessary, as well as providing users with supplemental information from the functional area anchor desks. The K-Wall could be flexibly configured to meet the changing operational situation, and it allowed for drill-down to detailed information. The TacGraph support application that was used for the generation of integrated readily digestible representations of tactical and other data was an unqualified success. Users appreciated the TacGraph-generated intuitive integrated graphical summaries available on the summary pages. They also liked the ability to interrogate these graphical summaries via embedded hyperlinks to supplemental information.

Future K-Wall implementations, however, will need to be designed to meet the user requirements that were not sufficiently supported by the initial K-Wall prototype. For example, K-Wall user responses suggested they had difficulty integrating information on the K-Wall, an important issue in future K-Wall displays. There is more to information integration than mere co-location, and there were calls for further data fusion and representation of inter-relationships across functional areas. Users also continued to express a desire for flexibility in configuring the display to meet the needs of different K-Wall users. The requirement for tools that support cognitively challenging tasks, in particular those that support the attention management, alerting, and collaboration were not perceived to be adequately met. The notification that new information had been posted by providers for viewing by senior staff is part of a more general process of communication and multi-tier collaboration that was highlighted during the game. Users expressed a need for the display of information about goals and commanders intent and about information age. Information providers need more guidance in the production of summary pages and associated content to produce relevant information that really adds value. Improving this collaboration—either through modified business rules and/or through the display of explicit context-sensitive CCIRs—will ensure that future information providers more clearly understand what they must push to the K-Wall so that senior staff get the information they need when they need it.

4.2. HOW WAS THE K-WALL USED?

The K-Wall was used continuously throughout the Global 2000 game. The fact that it became a focus during the game—it was commonly perceived as the place where the "action" was—is testament to the fact that it became the primary situation assessment tool for the CJTF staff. The K-Wall provided a means of visualizing mission-status in a continuous fashion, eliminating the need for a traditional 8-hour briefing cycle. Updating summary pages that were continuously available to the K-Wall users (and others) replaced the task of preparing briefings by the information providers and allowed them to perform it in parallel with other tasks. The K-Wall *was* occasionally used to brief K-Wall users. However, this use of the K-Wall was done on a more impromptu basis, as the operational situation demanded, rather than according to a set schedule. Usage of the CINC K-Wall on *Coronado* followed a similar pattern.

The operation and control of the K-Wall was typically performed by a dedicated, operationally savvy individual, under the direction of the other users of the CJTF staff, or in collaboration with them. The operator monitored its content for new information on a continuous basis, bringing relevant information into focus on the central monitors when necessary, in order that others could view and discuss it. The K-Wall was flexibly configured according to the operational situation, but almost always displayed some number of summary pages from the 13 functional areas or links from these pages. Tactical information and other tools were also commonly presented in the focus windows. The Web-based knowledge management approach that serves as a cornerstone if the walls design, was successful in supporting the needs of both the K-Wall users and the information providers—the most commonly accessed information via the K-Wall was in html format.

Several usability problems associated with the operation of the K-Wall were identified. These included confusion caused by the existence of multiple concurrent inputs to the K-Wall (multiple mice and keyboards and touch screen input), difficulties in navigating to information via the channel menu, and problems related to the poor visibility of the information and controls on the K-Wall. Despite these problems, however, operators and controllers of the K-Wall generally found it easy to use.

Summary pages from the 13 functional areas (and links from them to other information products) were the most commonly displayed information sources on the K-Wall. Tactical information and other software were also displayed as needed, especially on the large central focus monitors. Special-purpose summary pages presenting other information were also created during the game in response to K-Wall user requests.

4.3. WHAT NEW DESIGN REQUIREMENTS OR CHANGES ARE NEEDED?

The results discussed above identified many issues that suggest changes and new requirements for the K-Wall. These new requirements should be implemented in future K-Wall designs, in the design of the summary page, or in the form of summary page tools.

4.3.1. K-Wall Design

Subsequent K-Wall designs must address the issues discussed above that relate to:

- Alerting users to change in "hidden" information and directing users attention to important information currently displayed on the K-Wall (Overview page design, pointers, etc.)

- Integration of the K-Wall with other tools

- The visibility of information on the K-Wall

- The usability of the K-Wall

One of the ways that the current K-Wall attempted to alert users to changes in "hidden" displays was through the use of the Overview page. This page, which was displayed in the top-left monitor during a portion of the game, indicated the "worst case" value of the of the status alerts (Today, Tomorrow, or Long Range) of all of the 13 functional area summary pages, including those that were not currently being displayed on the K-Wall. It provided links to each of these summary pages. This allowed K-Wall users to see whether changes in status had occurred in any of the functional areas and to compare the status of all the functional areas "at a glance." In practice, however, the Overview page was rarely used by K-Wall users in this way. Further, it was not even displayed for almost an entire phase of the game. One highly likely reason for this was that changes in the overview were not automatically linked to changes that occurred in the summary pages it represented. Instead, the Overview pages had to be updated manually, and there was usually a time lag between when changes were made in the summary pages and when they were reflected on the Overview page. Further, the Overview page indicated a single value to represent all three of the summary page alerts, so users did not know when that status value had meaning (today vs. tomorrow vs. long range vs. all of these) and they could not answer questions such as "what is the predicted long term status of all the functional areas." A redesigned Overview page should be incorporated into future K-Wall designs, which should give users a clear indication of changes over time and provide integrated information to allow them to answer questions, such as:

- What is the current status of the different functional areas and how and when might this status change? (i.e., represent status over time).

- Are there any important events or problems that need to be addressed? (i.e., alert users to problems or events that might effect status) When will these events or problems have an effect?

- Have any important changes occurred in the content of the summary pages?

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- How do any changes, events, or problems in one functional area have an effect on the status of other functional area(s)?

Future K-Wall designs should also take into account the need for tools that support the direction of users' attention to important information that is currently displayed on the K-Wall. When K-Wall users wanted to discuss or brief information on the K-Wall they frequently used a laser pointer or the K-Wall mouse to direct other's attention to that information. This behavior suggests the need for a similar pointing device to be incorporated into the K-Wall software. The fact that the K-Wall is intended for use by multiple viewers suggests that some multi-user pointer might be valuable for briefing or discussing information on the K-Wall. However, a more difficult issue that future designs need to take into account is how to direct user's attention to information on the K-Wall that they are not aware needs to be attended. This issue is best addressed in the design of the summary pages, which are discussed below.

An obvious solution to the visibility problems of the K-Wall would be to alter its design so that it comprises fewer, larger monitors. Increasing the size of the displays would facilitate easier, more accurate viewing of text, graphics, and user controls. However, there is a trade-off with this type of design solution; it may introduce problems associated with reducing the number of types of information displayed at one time on the K-Wall. These include the attention issues already associated with the current K-Wall design, such as how to alert users of changes in the information that is not currently displayed on the K-Wall. It also creates problems associated with deciding what information should be displayed on the K-Wall monitors and how best to configure that information. Further, navigating to information not currently displayed on the K-Wall will become more difficult as the ratio of information windows to physical monitors increases and some means of supporting ease of navigation should be implemented. For example, the workspace control keys evaluated by St. John et al. (1999) could be considered.

Usability issues related to the operation of the K-Wall included those that were observed when multiple users attempted to control the K-Wall simultaneously. The K-Wall prototype used at the Global 2000 War Game could be controlled via two sets of mouse and keyboard inputs, as well as through the touch screen capabilities of the focus monitors. This occasionally led to confusion, such as when one user attempted to control the K-Wall cursor with the mouse and another user interfered by touching one of the focus monitors to access a link. Future K-Wall designs should consider how to allow multiple users to effectively control the K-Wall and how control can be shared and switched among users without confusion. Solutions to this problem might be incorporated into the K-Wall software but might also involve defining business rules related to K-Wall operation.

4.3.2. Summary Page Design and Links

The summary pages were designed to provide users a means to rapidly acquire and integrate information by providing them with a high-level, intuitively presented summary from the various functional areas. They provided a window into the "Knowledge Web" and a means to easily navigate through it, via links to more detailed information. The design features of the summary page (see Figure 5) included a tripartite status code (Today, Tomorrow, and Long Range) supporting the need expressed by users to know "how are we doing now, and how are we going to be doing in the future?" A consistent format was maintained across the summary pages from the different functional areas supporting rapid integration across them.

Several issues were identified, however, regarding the summary pages and the information that they linked to. These needs must be addressed in the future design of summary pages. These include:

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- Visibility issues: Layout and format changes
- Content and tools

A proposed change in layout and configuration of future Knowledge Walls (discussed above) featuring fewer and larger displays would alleviate many of the visibility issues related to the summary pages themselves. However, the information on many of the documents that the summary pages provided links to were perceived as difficult to see, even when they were brought into focus on the large focus monitors. Business rules that specify minimum sizes for text characters and objects should be implemented to ensure that the information on linked documents can be read easily by users.

The summary pages were designed to provide users a means to rapidly acquire and integrate information by providing them with a high-level, consistent summary from the various functional areas. Although K-Wall users seemed to be satisfied with the general categories of information displayed on the summary pages—current, short term and long term status and alerts, impacts, links and graphics related to alerts—several new content needs did emerge from the data. One of these was the need for the content to be tailorable, to meet the information requirements of different K-Wall users. Specific content needs, common to all K-Wall users, were:

- *The age of information presented on the summary pages and links.* The current K-Wall implementation provided time stamps on the summary pages themselves, indicating the most current update time. The links, however, did not usually include any indication of information age. An intuitive and, preferably, graphical means of indicating the age of information that is consistently displayed at all levels of drill-down should be included in future summary page designs.

- *The source of documents and other links.* When K-Wall users access a link, they need to remember the path that they took to access it, e.g., which summary page the current information was linked from. Indicating this type of information supports ease of navigation and prevents users from "getting lost" in the drill-down hierarchy. The most obvious way to implement this would be to provide the path of the link, in the same way that Web-browsers currently present source information. However, a better solution might be to present a more graphical representation, such as a tree diagram, that indicates to the user what the information they are viewing was linked from, what other paths could lead to the current information and the relationship between information at the same level of drill-down (see Card, Mackinlay & Shneiderman, 1999).

- *Tools that alert users to important changes in summary pages and links.* K-Wall users need to be informed when there is an important change on one of the summary pages or to one of the documents they link to. This need was indicated by the various methods (business rules, monitoring the blue links, e-mail, etc.) adopted by K-Wall users in Global 2000 to become apprised of changes in information. The design of the summary page must take into account how to indicate that a change has occurred, what the state of the information previous to the change had been, and at what level (of drill-down) the change occurred. A difficult task will be to implement methods that alert change in a way that is informative yet not overly distracting to K-Wall users.

- *Tools that provide feedback to information providers about K-Wall usage and information requirements.* In order for information providers to be alerted to the presence of change in their information products, they must know which of these products have been viewed by the K-Wall users. Future K-Wall implementations need to include a means for the K-Wall users to provide feedback to the information providers that they have accessed, for example, a docu-

ment or picture via a hyperlink on a summary page. This feedback tool might require users to explicitly provide this sort of feedback through the use of, for example, check boxes or other controls, or it might be transparent to K-Wall users and automatically update information providers every time a link is accessed. Implementation of any feedback tool must also take into account how best to represent this feedback to the information providers.

K-Wall users also need a mechanism to communicate to information providers their information needs and to provide them with their goals and CCIRs. One solution to this problem might be a tool, integrated with the K-Wall, that allows K-Wall users to send this type of information to the information providers. Another solution might be to actually give the information providers their own window into the K-Wall, or their own version of the K-Wall, so that they can see which type of information the K-Wall users are attending to and provide relevant information based on that. Of course, any window or workstation that provides such a view of what the K-Wall users are viewing must be designed with all of the above issues in mind.

5. CONCLUSIONS AND RECOMMENDATIONS

Observing and evaluating the use of the K-Wall prototype during a realistic, operational exercise provided invaluable insights. Overall, the Knowledge Wall proved to be a success. Support applications such as SumMaker and TacGraph were also considered highly successful. Most importantly, the concept of a "Knowledge Web," and tools such as the Knowledge Wall and Summary Pages that afforded a view into this web, were proven superior to existing tools and processes. The data and observations collected during the Global 2000 War Game (reported here and elsewhere) point to specific needs that must be met by future Command 21 research and development efforts. We recommend future K-Wall designs be developed and evaluated to address the needs set forth in this report. In particular, the following needs should be addressed:

- Cognitive tools to support attention management and change detection, including tools facilitating navigation to changed pages in the Knowledge Web.

- Tools and improved business processes to support multi-tiered collaboration, including feedback and guidance for information providers on content access of their pages.

- Design layouts to support improved text legibility.

- Information integration across functional areas—and to the extent possible, this integration should be graphical in nature.

- Information age and source information on the summary pages.

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APPENDIX A: DATA COLLECTION SUMMARY

Data were collected by:

1. Automated data collection: Access patterns and K-Wall configuration.

   a. Logs of URLs (timestamp, window, URL).

   b. Keystroke data: focus, hide/show refresh, presets.

   c. Screen captures: every 5 minutes.

2. Time sampling: of usage, configuration, verbalizations, preference etc.

3. Critical event/situation summary. [Provides context over time.]

4. Ergonomic analysis.

DVs related to:	Source	Data
Usage patterns	Time Sampling	Observed K-Wall configuration Observed K-Wall usage Verbalizations Nonverbal behaviors
	Log Files	URLs visited (Time and Window) Key presses (focus, show/hide)
	Screen Captures	Pictures of K-Wall content and configuration
Usability, interaction with K-Wall	Time Sampling	Verbalizations Nonverbal behaviors Observed K-Wall usage
New Requirements	Time Sampling	Requests for information, suggestions, comments, complaints
Preferences	Time Sampling	Answers to preference questions Suggestions, comments, complaints
Visibility	Time Sampling	Answers to visibility/legibility questions
	Ergonomic Analysis/ Measurement?	Viewing distance/legibility Axis of visibility Glare Occlusion
Ergonomic issues related to K-Wall use	Ergonomic Analysis	Room layout issues Environmental

APPENDIX B:
AUTOMATED DATA COLLECTED DURING GLOBAL 2000

The tables correspond to the figures presented in the report text.

Table 1. The percentage of time that tactical information was displayed in one or both of the K-Wall focus displays (Monitors 9 and 10) as a function of format of information and operational phase.

Tactical Focus			
C2PC in both Focus monitors			
C2PC in one Focus monitor			
TacGraph in both Focus monitors			
TacGraph in one Focus monitor			

Tables 2–3. Top table, percentage of time that a summary page was displayed on the K-Wall displays, averaged across all monitors. Bottom table, percentage of time that a summary page from one of the 13 Functional Areas was displayed on the K-Wall, averaged across all monitors. [SP = Summary page; AD = Air Defense, DS = Deep Strike, Eff = Effects, FC = Fires Coordination, GCC = Ground Control/CAS, ISR = Intelligence Sensors Recognizance, IW = Information Warfare, LOG = Logistics, OMFTS = . . . From the Sea, SOF = Special Operations Forces, SC = Sea Control, RS = Rear Security, TMD = Theater Missile Defense].

File Formats—All Monitors			
SPs			
C2PC			
Other			
File Formats—All Monitors			
AD			
DS			
EFF			
FC			
GCC			
ISR			
IW			
LOG			
OMFTS			

SOF			
SC			
RS			
TMD			

Table 4. The percent of time that output of the few cognitive tools was displayed on one the K-Wall focus monitors.

Tools Displayed on K-Wall—Focus Monitors			
C2PC			
WIGS			
TAPS			
TAC			
JFLEX			
CAESAR			

Table 5. The number summary pages and other information products (i.e., links) from the 13 functional areas that were accessed via the K-Wall, as a function of operational phase.

Number of Information Products from the 13 Functional Areas Accessed			
Summary Pages			
Links			

Table 6. The number of links accessed per hour of game play via the K-Wall as a function of format and day of game and operational phase.

Number and Format of K-Wall Pages Accessed as a Function of Operational Phase			
HTML			
MSWord			
MSPowerPoint			
MSExcel			
WIGS			

Tables 7-8. The number of functional area summary pages and information products accessed via the K-Wall as a function of operational phase of the game. [AD = Air Defense, DS = Deep Strike, Eff = Effects, FC = Fires Coordination, GCC = Ground Control/CAS, ISR = Intelligence Sensors Recognizance, IW = Information Warfare, LOG = Logistics, OMFTS = . . . From the Sea, SOF = Special Operations Forces, SC = Sea Control, RS = Rear Security, TMD = Theater Missile Defense, OVV = Overview, BC = Blue Comms, CSR = CAESAR]

Number of Summary Pages Accessed as a Function of Operational Phase			
AD			
DS			
EFF			
FC			
GCC			
IW			
ISR			
LOG			
OMFTS	.		
RS			
SC			
SOF			
TMD			
OVV			
TAPS			
BC			
CSR			
CJTF			

Number of Other Information Products Accessed as a Function of Operational Phase			
AD			
DS			
EFF			
FC			
GCC			
IW			
ISR			

LOG			
OMFTS			
RS			
SC			
SOF			
TMD			
OVV			
TAPS			
BC			
CSR			
CJTF			

Table 9. The percentage of critical events displayed on the K-Wall as a function of the format source of the information and the criticality of the event (1 = critical event, 2 = significant event, 3 = important event, 4 = event of interest).

Percentage of Critical Events Indicated on K-Wall as a Function of Source and Criticality			
Criticality 1			
Criticality 2			
Criticality 3			
Criticality 4			

Table 10. The average amount of time it took for critical events to be displayed on the K-Wall as a function of the format source of the information and the criticality of the event (1 = critical event, 2 = significant event, 3 = important event, 4 = event of interest).

Percentage of Critical Events Indicated on K-Wall as a Function of Source and Criticality			
Criticality 1			
Criticality 2			
Criticality 3			
Criticality 4			

Table 11. The K-Wall operations performed.

Number and Type of K-Wall Operations Accessed as a Function of Operational Phase			
Preset 1			
Preset 2			
Preset 3			
Preset 4			
Hide			
Show			
Refresh			
Focus9			
Focus10			
Home			

APPENDIX C:
OBSERVATIONAL DATA COLLECTED DURING GLOBAL 2000

Note: Observations made are presented in italicized text. Many of them are paraphrased or have been corrected so that they are grammatically correct. Comments taken from documents (such as the KM's documents) are presented in italicized, underlined text. Comments made during Global 2000 and Executive sessions are displayed in normal font.

OBSERVATIONS AND PLAYER COMMENTS

Information Requirements

Did the interviews identify the right information requirements?

Do the K-Wall design solutions meet these requirements?

Are there new K-Wall requirements?

14 REQUIREMENTS IDENTIFIED IN INTERVIEWS

General Requirements

1. (Shared?) SA

- Just looking at this thing [the K-Wall], it's not intuitively obvious what we're doing.
- It was useful for the CJTF; it was the only tool available . . . normally he would get SA from radios, people talking to each other . . . here the K-Wall was the only way to get SA.
- We need a common picture that gives instant SA to the commander when they walk into the room . . . this is a pretty interesting first step.
- Life would have been miserable if I didn't have this . . . because I would have been constantly pinging the other guys about what's going on.
- The CJTF did not have to 2nd guess commanders because of comfort he had. . . .
- SA increased in the CJTF but not component commands, partly because of the inability to put together a plan, intent.
- We didn't do a briefing at 8 o'clock, 1 o'clock . . . we didn't need to be brought up to date because we were always up to date. . . .
- It was useful for the CJTF . . . we had shared information, distributed sources. . . .
- . . . I was very comfortable that I was getting the information I needed. . . .
- . . . The K-Wall prevented information flow. . . .
- Speed of Command was increased by the improved SA of the CJTF. The K-Wall was a factor in terms of improved speed of command. SA was not good in the functional cells.
- [Regarding "working info into knowledge"] When I walked around during game play, this [the K-Wall] was the only place it was happening.
- The JFACC is holding a "live" situation brief every morning, efficient and direct, which is not possible using IT tools alone.
- The K-Wall is valuable in giving all a sense of what's going on, especially the CJTF and the CINC.
- The K-Wall does a reasonable job of keeping awareness level to CJTF and his staff.
- I found the K-Wall useful. The CJTF depends on the K-Wall almost entirely for awareness. . . .

- Yes, it's a K-Wall, it is a wall that prevents any knowledge from reaching the CJTF.
- It captures ideas that the K-Wall is actually supporting and continues knowledge transfer vice periodic knowledge transfer. It helped free players from the tyranny of preparing for a daily brief.
- I saw several cycles of support when the CJTF, prior to [Phase 2], had time to monitor the board—the functional commanders were making a great effort to keep the boss informed. As the pace of activity increased due to the transition to [Phase 2], they reverted to other means of maintaining awareness, primarily physical meetings and email, and the CJTF became overwhelmed and was unable to focus on the bigger picture on the wall.
- It allowed the CDRs to rapidly assess information for use in making decisions.
- The value grew over time as both an SA and synchronization tool as separators became familiar with both the concept and how to feed into it.

2. Integration

- Only the CJTF can look at all the screens at the same time.
- I see this as valuable because we can put different formats up there to discuss things.
- The K-Wall was a good first step. We need better integration . . . it was hard to see everything. . . .
- The CJTF is the integrator because of more screens.
- An advantage we had over the component commanders was not having a single page but multiple screens.
- It's hard to integrate stoplights [status alerts]. . . .
- It allowed us to look at the same information at the same time and discuss it.
- This is the only place where you can bring everything together. [regarding the NCA having access to summary pages but not the K-Wall]
- The information presented on the wall was not fused from relevant functional areas. However, it gave the false impression that it was. . . .
- Fewer screens with integrated data would be a better answer.
- The next step is . . . a relationship between the FA automatically updating . . . and fusing information . . . tailored to a job or function. . . .

Format Requirements [NB these comments are related to general K-Wall format only, specific format of summary pages are below]

3. Intuitive, Graphical

- The technology, a lot of it being the K-Wall, was fairly intuitive. . . .

4. Consistent

- An observed problem is that navy personnel don't know what army symbols are—a suggestion was made that there should be a roll-over function in TacGraph that shows a description of a unit.
- There is no way to have one metric for all FAs . . . If we were together for a longer time, a metric would develop.
- We need standards of use (e.g., colors used, processes completed, level of detail, purposes, etc.). . . .

- We need to determine what level of information you see at first blush.

Content Requirements

"Content and people make the K-Wall useful—without them, it is simply monitors."

"Garbage in–garbage out."

5. Tactical focus

6. Supplemental information (Other content provided—Overview page, etc.)

- When I'm looking for pages, I don't use the overview slide. . . .
- At the beginning of Phase 2, the Overview page was no longer being displayed, and no one seemed to use it . . . later in Phase 3, the Overview page was brought back up. [NB is different from the K-Wall operator]
- The K-Wall-Op reported that he used the red alert on the Overview page to know to look at the hidden Rear Security page.

7. Goals and CCIRs

- It did not provide the commanders intent to me . . . how come I had to come up here to tell the commander what's going on.
- The CJTF level did not feel comfortable . . . with no way to sync with higher and lower levels—no way to push info or convey needs/plans/intentions.
- [*Discussing the CJTF page*] We need to include things like the commander's intent, Today ' (what we plan to do for next 10 days). . . .
- We need to restrict what goes on the K-Wall. It should be top-down drive. . . . The CINC gives CCIRS. . . . but these are mission dependent. . . . We really need a constant baseline for information and mission related additions.
- When the component commanders let the CJTF know they were having trouble knowing what the CJTF wanted, it led to the development of the a CJTF page.
- Need to define better what "Today," "Tomorrow," and "Long Range" mean. Some areas (e.g., Sea Control) used them better than others. Information requirements and CCIRs should be considered.
- Commander's priorities must be made clear to all. Shared awareness must include CCIRS/priorities etc., or it's not shared.
- *The overall battle plan is not really reflected on the K-Wall. . . .*

8. Anchor Desk Output

- FA summaries on the K-Wall 100% of the time
- *On focus monitors X % of the time*

9. Connectivity/Collaboration (K-Wall, IWS, VTC)

- One problem is that when [a problem] is supposed to be taken care of by Navfor, how do I know whether they've taken care of it? . . . Do I need to send them an e-mail asking about it? . . . .
- The K-Wall is really a centralized control at the top, not a component. How do we make collaboration work? Components need to collaborate.
- Groups that were on IWS did use chat for collaboration.
- There was a need for better shared awareness/collaboration.
- The VTC was worthless, actually negative because poor execution made it a distraction . . . maybe they thought they were sharing information but they weren't. It should only be used in certain situations.
- What made it work was the table, people around the table, verbal communication . . . great for passing information up and down . . . but I missed face to face and verbal communication from commanders to work . . . needed to get the headphones to work, the VTC to work.

10. Cognitive tools (see new tools and SP tools)

Feature Requirements

11. Flexible configuration

Across Contexts

- Now that we are no longer in [Phase 1] and in [Phase 2], I need to see information relevant to that . . . only certain pages.
- At the beginning of Phase 2, the Overview page was no longer being displayed, and no one seemed to use it . . . later in Phase 3, the Overview page was brought back up. [NB is different from the K-Wall operator]
- We need to replace that overview with ground control.
- The limitations were lack of flexibility in reconfiguring it and the display technology inability to export pictures to show other locations in the JCC and components that the CDR was focusing his attention upon them.

Across Users

- Whose tool is it? If three groups, CJTF, CINC, NCA, can see the K-Wall they need to see different information . . . One K-Wall glove does not fit all - there needs to be tailorable information. . . .
- The big issue is who uses it. Information presented should differ. It should be tailored to specific users/user groups.

12. Drill down (also see frequency, depth, content of drill-down in usage logs, screen captures)

- There is a problem with too many links, I don't want to drill down to say "mother may I."
- When I click on a red gumball there are no links . . . drill-down is not being supported.
- When you hit a button, (today, tomorrow, long range), there should be an indication of what's going on.
- I just want our guys [ISR ADs] to be thinking about how to update information, so you can drill down.
- Some of the dots have changed color but they still don't have links associated with them.
- An example of what people called a "good link" was the METOC brief using the K-Wall—the grids have links to drill down, color coding etc.

- [*In a comment about how intuitive technology was*] We could view the FA information, could drill down for more information.

Information Source

- The problem is that pages/links don't indicate where they came from . . . need to include addresses or headings on links.
- Left side [information in focus monitor 9] is from . . . ?

13. Information Age and Reliability

- One thing we've heard about the K-Wall this week is "how current is the information?"
- [Pointing out how long it takes to update the page, and how this leads to outdated information being displayed on the K-Wall] The problem is that it's not plugged into anything . . . it takes so long to update, throw on overlays, that it's old by the time it gets up there.
- A lot of these things don't have times on them, so we don't know how old they are.
- It's been good when the guys are updating it.
- Currency of information is a big issue with the wall, in terms of:
  - how long to produce products
  - how to present/link/publish products

14. Tactical overlays

- It would be very useful to have access to a map/chart [like a NIMA map] that we can put on the K-Wall . . . This is a whole new category to go on the K-Wall: access to a "reference library" of our own. Things on WIGS, order of battle, capabilities of ships, reference manuals, maps . . . with a searchable database . . . everything that I have on notebooks right now.
- We need a tool for the wall with overlays, to display METOC and ISR. . . .
- There is lots of use of TacGraph tactical pictures on summary pages, especially 2nd level links.
- There is the use of C2PC overlays (see screen captures).
- In a perfect world you want a real time map that you can add layers to from METOC, sensors etc. . . . a pull vs. a push system. . . .
- There is the need for layered data controlled by the DMs (i.e., overlays)—fused, configurable. . . .
- Players are actually trying to find the full capability of the systems. They are trying to import data from C2PC onto TacGraph. Both systems have good features that the other doesn't. They want real time data from C2PC on the TacGraph chart for manipulation.
- *. . . most of us desire a consistent tactical picture. It's mainly semantics, but I'd argue that the C2PC is inappropriate for the CJTF and above. But those procedures for providing the "picture" need refining. Clearly tools like* TacGraph *are great for rapidly building a picture that can express information concisely and rapidly . . . need training, not on how to operate the tool but on how information can be presented . . . visualizing information. . . .*

NEW K-WALL REQUIREMENTS

NEW CONTENT

Information Source

- The problem is that pages/links don't indicate where they came from . . . need to include addresses or headings on links.
- Left side [information in focus monitor 9] is from . . . ?

Other (non-FA) Content

- Requests for or development of pages with information from:
  - CJTF (to push to component commanders, up to CINC)
  - METOC
  - Blue's Red cell
  - Blue comms
  - Searchable reference library—maps, ROEs, capabilities, etc.

New Tools

Alerting Tools (see SP tools but idea also applies generally to K-Wall)

- There have been lots of requests for the CJTF to have control of alerts—to be able to alert everyone else (i.e., push information to everyone else).
- The pages that aren't displayed on the K-Wall don't get looked at.

Attention Management (pointers etc)

- [To collaborate...] We each need to have our own different colored pointers so we can talk about the same things together.
- Briefings and discussions using the K-Wall frequently involved the use of a laser pointer.
- You need the ability to have a pen or light you can use to draw on the board from a distance . . . a mouse pointer/pencil device.

Feedback to ADs

- We need a way for K-Wall users to convey desires/disseminate information "down" to anchor desks and lower echelons.
- [*AD in the same room as the JCC*] I have an advantage over people downstairs because I can walk over and see if they've looked at my links or not [*using the color of the link text as an indicator*].
- Give the admirals a "laser" and check boxes that they can check once they've read something.
- . . . there should be a feedback loop and rules for stoplights.
- There needs to be automatic feedback that the page has been read.
- A KM fix (business rule) was to add an <u>asterisk</u> a new link and <u>have the BWC contact the AD when it's been read (via e-mail)</u>. Also, include an <u>exclamation point</u> after a link that the AD thinks really needs to be read/addressed.
- There needs to be a feedback loop on the K-Wall from the BWC to the AD/FA.

- Feedback notification is required when something urgent has been received by the CJTF.
- *I recommend that the signal be cleared once the CDR views the status.*

Other
- Built-in chat with functional areas for summary pages would be useful.
- Webcam32 might be a tool for future use on the wall.

New Methods of K-Wall Operation/Access
- It would be nice if the K-Wall was connected to the BW displays, so when the BWCs say we need to look at something, there's a button that brings up the content of their display onto the wall.
- There's an issue of putting old files in an archive that can be liked to through the wall.

K-WALL USAGE AND USABILITY

Usage Context: When and How
- The K-Wall was used as a "situation assessment tool," continuously viewed by JCC staff.
- The K-Wall was used as briefing tool by component commanders to individual or groups of JCC staff.
- They (AD personnel) have acknowledged that the K-Wall is more important to briefings. Everything that's there can be used to brief . . . Everyone needs to be updating their pages.
- . . . a good tool to transition in and out of briefing and for [assessment].
- The K-Wall was used to review information to put on the CJTF page.
- The K-Wall was used for briefing, discussion of information without having to stop the war.
- We didn't do a briefing at 8 o'clock, 1 o'clock . . . we didn't need to be brought up to date because we were always up to date . . . we didn't have to go off for 2 hours and prepare a brief.

Usability Problems, Ease of Use
- It's an issue (training or otherwise) that the information providers need to not put a link to a document that they are working on. The K-Wall operator needs to know what's open
- When 2 [identical] pages are on the K-Wall (e.g., on a peripheral and a focus monitor) and a link is clicked on one of them, the color of the link only changes on that page and not the other one. You need to show the change on both pages.
- The pages that aren't displayed on the K-Wall don't get looked at.
- Where's my mouse? [wiggling the mouse to find the cursor]
- It was found to be useful by most users. . . .
- Navigating using the channel menu is inconvenient. For example, getting to WIGS involves many steps.
- With less than 2 weeks of use, the team was able to efficiently use the K-Wall.
- *The K-Wall is useful, but it's not easy to move contents to another screen. Example: moving the ISR picture to the big screen.*

Visibility of K-Wall

- If you're near-sighted, you can look through fingers [holding fingers to eye] to see it.
- When I look at the picture on my page, I can't see it. [*not a problem once it's clicked and enlarged*].
- It's hard to see items in pull down menus when trying to bring up a new summary page [in monitor 11].
- Here's another part of the K-Wall: you've got to have good eyes.
- The K-Wall operator frequently walked up to monitors 9 and 10 to read them.
- K-Wall users occasionally printed pictures to look at them (more common on the Coronado).
- He [the CJTF] couldn't see the Strike page, so he brought it up on his laptop.
- Whenever I say, "hey COS look at this on the wall," he has to get out his glasses.
- Can you see that tab? [on bottom of Excel page on M9—other BWC's head blocking his view].
- With all the monitors, needing to focus eyes is a problem. If people have a headache they can't make decisions.
- *Many of the monitors are too far away to see easily in JCC*.

Who used/viewed/attended the K-Wall?

- Some personnel (e.g., J3) primarily looked at a laptop, but occasionally did use the K-Wall to discuss information with others. Later these personnel used the K-Wall much more. Others (CJTF, COS, J6, etc) looked at the K-Wall throughout.

K-Wall operation: who operated the K-Wall, who controlled the content of the K-Wall, methods used by operator/controller?

Evolution of K-Wall Operation/Control

- Early in the game the BWC was the operator of the K-Wall (he had experience from NDIA)—he had the responsibility of looking for changes, bringing them up on the wall, and drawing the attention of the CJTF staff to important changes/info. Later, other BW personnel were the K-Wall operators; and the CJTF personnel became more active, requesting that information be brought up on the wall or onto focus screens to better notice changes.
- [CJTF to K-Wall operator, BWC] You should notice when changes occur and bring it up on the wall.
- I'm looking for blue text [= *new link, unaccessed*] as an indication of new information, since there isn't anything flashing to let me know it's changed. Sometimes they [CJTF et al.] ask me to bring stuff up on the wall.
- There was an evolution from them looking for information to bring up on the wall to seniors requesting information that they knew was there.
- Knowing what and where information is located (and that it exists) is vital to making the wall useful.
- The K-Wall operator evolved into the Knowledge Warrior. . . .
- *In order for the K-Wall to be successful, there must be a person dedicated to operating it, and components must be notified well in advance of requirements*.

Preference and Comparison to Other Tools

- This is much better than what we had before, better than a stickpin in a map. . . .
- The K-Wall was a hit. . . .
- It's a great information filter, but there are problems. . . .
- [Issue of defining what alerts mean] wouldn't be important if they didn't like the K-Wall, but that's what they're using.
- [*Discussing Global 2000 in general*] We're just light years ahead of last year . . . but each year *should* get better.
- [The K-Wall] is a good idea but it needs some tweaking. . . .
- CINC had more negative comments. . . .
- [*From AD perspective*] . . . as people got used to the tools, then there was more use, more "let's put this on the wall". . . .
- The K-Wall was a good first step. . . .
- Life would have been miserable if I didn't have this. . . .
- It's a great tool you've got here, don't get me wrong. . . .

SUMMARY PAGES

Did the summary pages have the right content/format?

How can the summary pages be improved?

Summary Page and Links Content

Summary Page

- An initial problem was: "what should be on . . . . page?"
- It's important to communicate and have a common understanding of what should be on the wall.
- We need to define what 24 hours, 48 hours, long term means.
- For ISR [summary page], instead of today, tomorrow, and long range, I want to see air, land, surface, subsurface with links to C2PC.
- Effects page—the alerts changed to Past 72 hours, Next 72 hours, Long range.
- [*Discussing CJTF page*] We need to include things like the commander's intent, Today (what we plan to do for next 10 days) . . . what's going on today, tomorrow, etc.
- Something I know the CINC is going to want to see is how we're doing on Effects . . . we should highlight this . . . how we have done . . . that's [TAPS] what we've done. . . . unintended consequences, etc.
- We didn't ever define what today, tomorrow, long range was . . . Sea Control had a good method = Today: what I'm going to do today, intentions, etc.
- [CJTF page] We noticed we weren't updating our seniors so we developed a CJTF page. Both Admiral Zelibor and I decided what would go on it via discussion.
- [*Regarding status alerts*] We need to understand what each rule set is and how it is being used by each cell and document it for the CJTF and CINC. The rules can be different for each FA as long as the CINC and CJTF know the rules.

- The stoplights don't tell me anything because I don't know what metric was being used . . . we didn't really look at them. All red told me was that the commander was uncomfortable with what was going on.
- Do you have any way of indicating effectiveness?—keep it at high level.
- On K-Wall, the overview stoplight graph does not automatically reflect the status of the various summary slides when they are updated.
- That's what we want to see: what they're planning to do today, what are their intentions for tomorrow. . . .

Links

- When you hit a button, (today, tomorrow, long range) there should be an indication of what's going on.
- When there's a yellow or red alert, the functional areas should tell you what they're doing about it.
- When you change the color of the alert, we need to know why the alert changed.
- That's what we want to see: what they're planning to do today, what are their intentions for tomorrow. . . .
- [CJTF page] . . . alerts should be . . . what's imminent, ROEs, things like that.
- [CJTF page] The CJTF should provide the CINC with a picture of what's going on so he can let others know. . . . Take the best of the best from the other summary pages. Not specific details but the big picture. Keep an eye out for pages that can be used for this. We're going to link to links.
- [*Pointing out that someone linked to the battle plan in* WIGS] If it's in there and we can find it, we'll use it.
- [The text on a link from a yellow status alert included a <u>description</u> of why the text/alert was yellow] They should all do that!
- A lot of these things don't have times on them so we don't know old they are.
- *It is a problem that pages/links don't indicate where they came from . . . need to include addresses or heading on links.*

Summary Page and Links Format

Summary Page

- Suggested changing the summary page layout so that the entire page is a picture with a small window of alerts/links in the corner.
- We need standards of use (e.g., colors used, processes completed, level of detail, purposes, etc.).
- There's too little room on the summary page.
- What is lacking is a means of summarizing information on the K-Wall and passing it up [to the CINC]. . . . What are the implications, how are things unfolding. . . .

Links

- When graphics link to PowerPoint slides—use simple text, no logos, no pictures . . . need information . . . use black and white text . . . the links are just [too] full of stuff.
- . . . too much data, need simple PowerPoint slides.

- I put the most important information on the last slide (of 10)—they never even looked at it . . . you need to put the most important information on the first slide.
- If they put a lot of text on it, I just skip right over it [*when monitoring the new links*]. The information needs to be condensed.
- Keep things simple, use big bullets. . . .
- A business rule should be: don't use too many acronyms because not everyone understands them.
- It is a problem that pages/links don't indicate where they came from . . . need to include addresses or headings on links.
- That was a good link, that was a good picture. [TacGraph *picture, link from SOF page]*
- Italicized text on the link is hard to read.
- Yellow text . . . hard to read on white background. The Marines don't listen very well.
- If a whole page of text was on the K-Wall, we didn't even read it.
- I want to show [pictures] like this [TAPS], not so much bean counting. . . .
- I know I can highlight these [*objects on* TacGraph *picture on M9, i.e., link to information*] but there are too many things up there.
- Too much detail . . . if you had a picture showing the same thing, that would be great. [*list in Word doc, small font*]
- The SOF link to the .avi file (SEAL video), 42MB, the AD says this is how they normally do reporting → need a definition of what types of files can be linked to, how big etc.
- They are not using TacGraph enough, they should because there's not a lot of space on a page . . . a graphic would have told a thousand words.
- Several FAs were linking summary status alerts to a PowerPoint presentation—it took forever to update . . . can't updates be updated with an html file. Also having a standard way of representing a report would help SA . . . we are seeing different color information with no idea what each color means. . . . still having to guess about why an item is red.
- *A shift to saving all files as html was involved but the K-Wall designers didn't think that is always a better thing to do. Template makers should look at the size of a file after saving to make sure an html file is not larger that the original.*

SP Update

- Some of the dots have changed color but they still don't have links associated with them.
- It is also a problem that alerts stay the same color.
- The ISR AD walks up to let the BW2 know that his page is updated [a result of decreased refresh rates].
- Is the game paused? Why is nothing updating?
- The game is progressing smoothly . . . the K-Wall is getting updated regularly.
- *As a process for updating the K-Wall (OMFTS), the AD updates pages process involves links to pages which are automatically being updated by cognizant function.*

SP Tools

Alerting when SP had been changed or updated

- Change the stop lights so they flash when changed, like the gauges on WIGS.
- There are problems . . . with automatic alerts and things like that. . . .

- When they update their page they need to update their links [a *problem with new links not being blue*].
- .... there isn't anything flashing to let me know it's changed.
- *On the K-Wall, the overview stoplight graph does not automatically reflect the status of the various summary slides when they are updated.*

Fixes to alerting problem used during Global

- A KM fix (business rule) was to add an <u>asterisk</u> a new link and <u>have the BWC contact the AD when it's been read (via e-mail)</u>. Also, include an <u>exclamation point</u> after a link that the AD thinks really needs to be read/addressed.
- Suggest the use of 'Last update date' to determine when pages were last updated.
  - Has ... been updated?
- BW and K-Wall-op monitoring "blue link" and verbal alerting [but problems exist with this. . . .]
  - I'm looking for blue text as an indication of new information. . . .
  - When I'm looking for pages, I don't use the overview slide . . . I look for blue links and asterisks.
  - We could use blue links and time. . . .
  - [*BW announcing*] New alert on ISR coming up on the summary page.
  - TMD's got something new. [referring to blue link]
- Notification (by ADs) via e-mail, chat, phone (to BWC or K-Wall techs), walking up to JCC
  - *e-mail to J3*–per K-Wall update. . . .
  - chat [in IWS] to J35— "I've updated K-Wall page."
- Use of colored text or pictures to alert (by ADs)
  - Use the picture area to alert (with text "alert").

Feedback to ADs

- We need a way for K-Wall users to convey desires/disseminate information "down" to anchor desks and lower echelons.
- [*Information provider in the same room as JCC*] I have an advantage over people downstairs because I can walk over and see if they've looked at my links or not [*using color of link text*].
- Give the admirals a "laser" and check boxes that they can check once they've read something.
- . . . there should be a feedback loop and rules for stoplights.
- There needs to be automatic feedback that the page has been read.
- A KM fix (business rule) was to add an <u>asterisk</u> a new link and <u>have the BWC contact the AD when it's been read (via e-mail)</u>. Also, include an <u>exclamation point</u> after a link that the AD thinks really needs to be read/addressed.
- There needs to be a feedback loop on the K-Wall from the BWC to the AD/FA.
- Feedback notification is required when something urgent has been received by the CJTF.
- I recommend that the signal be cleared once the CDR views the status.

K-Wall Access and Communication Issues, CONOPS, Training, Business Rules

- Who should have access to the K-Wall summary pages?
- Who should have access to a K-Wall?
- How flexible/tailorable should K-Wall/SPs be (wrt different users)?
- How does the K-Wall promote/prevent vertical and horizontal communication?
- How does the K-Wall change the CONOPS?

K-Wall Access (who, how and what)

Access to Summary Pages

- Another important feature is that you can call pages up on other machines.
- There was a request by the BWC for a CJTF summary page that the ADs can access and development of CJTF page for CINC/NCA access.
- [CJTF page] We have this CJTF page, let's make sure we use it today.
- The ISR summary page is being displayed on the J2's console.
- The COS asked what was on M9 so he could read it on laptop.
- We [MARFOR] checked the other pages periodically.
- *. . . the individual functional and component staff officer still faces daunting challenges in sorting through reams of links. I recommend that next year we give players their own personalized portal.*

Access to a K-Wall
FA Personnel, etc.

- [AD in the same room as the JCC] I have an advantage over people downstairs because I can walk over and see if they've looked at my links or not [using color of link text].
- Several cell personnel (in same room as JCC) have come up to ask where the ISR picture (they can see on the K-Wall) is located (i.e., they are looking at the K-Wall).
- An advantage we had over the component commanders was not having a single page but multiple screens.
- Lower echelons need some way to tell what is currently being displayed on the K-Wall. An HTML page with a table divided like the screens, showing the title of each panel content, with a link to that content, would help.
- There are questions on whether the large screen displays on sides of JOC can be slaved to show what the head table is viewing up close on the K-Wall? These are not hard requirements for this game but objective to allow watch standers to see what the head table is looking at.
- *Since the K-Wall was only viewable from JCC, don't believe the K-Wall was of much value [to the cells].*

CINC/NCA

- There was concern expressed by the JCC staff that the CINC isn't seeing everything they can.
- The same concern was expressed by the CINC.
- . . . . we noticed we weren't updating our seniors, so we developed a CJTF page.
- What is lacking is a means of summarizing information on the K-Wall and passing it up. . . . What are the implications, how are things unfolding?

- Because the CINC doesn't have a K-Wall, the CJTF, via the BWC needs to be in contact to keep him updated *[the connection to the Coronado was down, the CINC played in NWC with no K-Wall]*.

Tailorability of K-Wall

- There's a problem with [the CINC having] too much access to information, whether it's stoplights on pages or e-mail.
- The tool is for the CJTF and the CINC shouldn't be bugging MARFOR, etc. [related to Zelibor's comment above]
- Whose tool is it? If three groups, CJTF, CINC, NCA, can see the K-Wall they need to see different information . . . One K-Wall glove does not fit all—there needs to be tailorable information . . . A green status alert does not mean the same to everyone.
- Do we give everyone access to all the K-Wall and hope they access only the information they should or restrict access (e.g., NCA should not see C2PC; information may be different if people know the CINC, and everyone else, might be reading it).
- The CINC/NCA should have a customizable version of the K-Wall.
- [Problem that the CINC was] more worried about what CJTF was doing instead of what they should communicate to NCA

Push/Pull: Definitions of What Goes on Wall/Communications of Commanders' Needs

- There were lots of requests for the JTF to have control of alerts—to be able to alert everyone else (i.e., push information to everyone else).
- The CJTF page is being created that is accessible to the CINC and component commanders.
- The CJTF should provide the CINC with a picture of what's going on so he can let others know. . . .
- A lot of people are wondering, all this stuff is going to the K-Wall, but how do they know what is being looked at, what are they getting back. . . .
- Commanders should be driving K-Wall requirements—in the beginning let the pushers drive the wall.
- Sometimes we (CJTF personnal) asked a question and they answered it by pushing to the wall. Other times, we didn't know the question to ask and they gave us information.
- We need to restrict what goes on the K-Wall. It should be a top-down drive . . . the CINC gives CCIRS . . . but these are mission dependent. . . . We really need a constant baseline for information and mission related additions.
- A conversation between CJTF, CINC and ADs is needed about what the stoplights mean. Higher ups must have a definition, but the ADs are not giving it.
- The ADs should define this . . . The CINC wants a standard definition but thinks it's OK if the ADs change it . . . this doesn't make sense. Define what should go there and then what the colors actually mean.
- The definition is a cultural issue (e.g., different for a commander at sea than a marine).
- We need way for K-Wall users to convey desires/disseminate information "down" to anchor desks and lower echelons.
- There's an issue of push/pull—what gets put on the wall? What the Anchor Desks want to push up, or what the decision makers need?
- The "CJTF" page is vital to provide two-way communications to the team.

- The K-Wall is great for passing information. . . .
- The CJTF level did not feel comfortable with no way to sync with higher and lower levels—no way to push information or convey needs/plans/intentions.
- The commander's priorities must be made clear to all.
- We need to define what 24 hours, 48 hours, long term means. [Slaght]
- At the beginning, information flow was internal only - getting their act together and sharing knowledge about plans, scenario, and system. After Day 1, the players were concerned about sharing information with their functional areas. Next, sending information up the chain. The best example during Globe 00 was problems seen in populating the K-Wall.
- Concern that stoplights on K-Wall are being interpreted differently by each of functional commanders. What business rules are needed from CJTF to ensure consistencies? (What would KM role be here?)
- When things got hot and heavy, we saw the lower level DMs pushing information and requesting for decisions up, inundating the CJTF with email vice using the K-Wall as a vehicle for communication actions taken.

Issues Related to Updating Summary Pages

- If you really wanted to do this right, you'd have to have someone updating the pages full time.
- It was a burden for echelons—but more so than preparing the daily brief? Some thought it was, others did not! More so in first week, as people got used to the tools, then there was more use, more "let's put this on the wall."
- The use of the K-Wall is manpower intensive in that many people were involved in its use—and the preparation of the content.
- The requirement to post separate links on both K-Wall summary pages and the Battle Plan (both future and current) increases workload and leads to conflicting information. If we had clearly defined products, we could just update products and links to them could be automatic.
- We believe the collaboration needed to produce documents such as summary slides put an unnecessary load on the IT tools and the people involved.
- Overall problem: Task saturation for the AD person. You can't fight war plan tomorrow's fight, and do K-Wall duties.
- Problem: the AD person was very involved in planning the battle . . . updating the K-Wall was a burden in the beginning. Bottom line: for a nearly real time K-Wall, a dedicated person must be there. If not, the K-Wall will be populated when the AD can get to it. It will be populated with information that is not timely, but a placeholder that appeases higher ups and looks good.
- How do you capture when K-Wall summaries are no longer something, which is seen as a separate task but instead is just another means of keeping the boss informed.
- From the information provider view, it was considered a burden—the K-Wall was seen as a collateral duty. There were too few people having to populate the K-Wall, drive the game with battle plans, and also update the K-Wall.
- Summary page development and update is a full time job and is best manned by an operator who understands the mission area and the commander's part in the mission. They have become very adept at updating.
- Well-manned mission areas are being updated faster than poorly manned ones.

Horizontal Communication

- There are problems with the communication between the different functional areas.

- It's hard to integrate stoplights . . . there has to be horizontal integration between the functional areas to say how does this [red alert] impact you.
- We need to establish linkages between functional areas.
- How do we make collaboration work . . . components need to collaborate.
- The goal should not be to increase manual coordination through chat rooms but to increase shared awareness through better automation.

Training and Business Rules

Other tools: TacGraph, C2PC, Caesar, TAPS, WIGS, IWS

How well did these tools integrate with the K-Wall?

What problems, benefits etc. were associated with tools?

General

- There are too many independent databases . . . they don't correlate input from the war game. If input is made it should update everything TAPS, C2PC, TacGraph, and K-Wall should be linked.
- *Most players use multiple windows, but products do not alarm you when new information becomes available. Since the screen isn't that big, it's difficult to keep multiple windows open.*

C2PC

- C2PC isn't Web-based—which is a problem since everything else is.
- That's why I hate C2PC, none of that's accurate.
- Bring up C2PC for situational awareness.
- *C2PC—good enough for operational level play.*

TacGraph

- I thought that TacGraph was a more detailed picture of C2PC, but it's not.
- It needs to be integrated with C2PC.
- They're not using TacGraph enough, they should because there's not a lot of space on a page . . . a picture is better than words.
- I know I can highlight these [*objects on* TacGraph *picture on M9, i.e., link to information*] but there are too many things up there.
- An observed problem is that navy personnel don't know what army symbols are—a suggestion was made [BWC] that there should be a roll-over function in TacGraph that shows a description of a unit.
- A problem [reported by AD] is that the font can't be changed for Title in the TacGraph file.
- Players are actually trying to find the full capability of the systems. They are trying to import data from C2PC onto TacGraph. Both systems have good features that the other doesn't. They want real time data from C2PC on the TacGraph chart for manipulation.

- The SC summary graphic uses a C2PC backdrop. What about using TacGraph or IMAT, since it can show more useful information.
- Clearly tools like TacGraph are great for rapidly building a picture that can express information concisely and rapidly . . . need training, not on how to operate the tool but how information can be presented . . . visualizing information. . . .
- On TacGraph, the zoom needs to be variable. The operator would like to be able to control view he/she sees.
- TacGraph: I believe this is a fantastic tool, which was brought in too late in the game. Its graphics are outstanding and its bandwidth is conserved when documents are published in JPEG format.

IWS

- IWS generally was not liked from all perspectives—but functions offered by products like IWS were desired.
- The groups that were on IWS did use chat for collaboration.
- The whiteboard used by some groups–would have been useful for ARFFOR to communicate with the CJTF.

WIGS

- Opening summary pages from FAs in WIGS caused the text to wrap (on the laptop). This was fixed when settings were changed to a large font.
- We need to get everything on WIGS instead of K-Wall so we have accountability and then push it when it's ready.
- Navigating using the [K-Wall] channel menu is inconvenient—e.g., getting to WIGS involves many *steps.*
- Alerting on WIGS stopped happening late in the game.
- I used it as a reference library to go get documents . . . the concept is great . . . people want every system to be connected to a centralized database. . . .
- The alerts were useless because not everyone had WIGS up and you had to click on the alert to see what it was . . . If there's an alert, I want the screen to light up—I don't want to have to pull information.
- I wasn't sure if I had current information, reliable information. I need confidence that the information is current and up to date . . . people talk about time stamping . . . we need source of information and validity.
- I need to make sure I'm getting information from my echelon . . . and if I need more I can go get it.
- There was a problem when you're linked to the battle plan and there's an update [doesn't update on your screen] on WIGS, how do you know what's current?
- All systems should be available or accessible via WIGS. It's very hard to find what you are looking at.
- The concept was sound thought, and once you became familiar with it, it could be useful. The "link-map" is necessary so you can figure out how to use them and where they are.
- WIGS: *the only method to get SA from a distributed site.*

TAPS

TAPS was displayed on K-Wall X % of time (#sfrom screen captures, log files)

- There was a discussion of using TAPS to show Blue's intended actions and what Red thinks their status is (is this what it really represents?).
- We're going to take TAPS and put values on it, even though it's not working.
- TAPS would be nice, if it's working . . . Is TAPS updated on here?
- . . . that's [TAPS] what we've done . . . there are unintended consequences, etc.
- It's ahead of its time . . . Maybe it's more of a decision aid. You don't use it to make decisions . . . It shows general flow, are we heading in the right direction. . . .
- COP should not exist . . . a CO baseline should, a shared story . . . it could be TAPS at the NCA level.
- . . . a great idea but manually intensive.
- It's a great idea but the information is timelate and manpower intensive; it should be automated. It's an immature tool—useless now but maybe good some day.
- I don't know what this is telling me!
- How is the data relevant to the mission?
- This is a bean counter's tool.
- I don't trust it because I don't understand it.
- As executed in the game, this is a very immature tool. It looks like it should have been good, but information input was from different people with different subjective opinions. If you don't know where you are going, any road will get you there. . . .
- No decision points, no triggers, no sense of progress—maybe it should be a decision aid. This is way ahead if its time.

CAESAR

- CAESAR summary page is displayed on M9; then a link to CAESAR PowerPoint document, accessed via the CAESAR channel = single time CAESAR was displayed
- I put the most important information on the last slide (of 10)—they never even looked at it . . . you need to put the most important information on the first slide.

JFLEX

- JFLEX plan is displayed on M9 (for the first time). It was a link from JFLEX summary page (Misc Links) = single time JFLEX was displayed.

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14. ABSTRACT

A wall-sized, shared display, or "Knowledge Wall," was implemented onboard the USS *Coronado* (AGF 11) and at the Naval War College (NWC) for evaluation during the Global 2000 War Game. The prototype KW was designed to meet 14 user requirements identified in a previous cognitive task analysis of potential KW users. This report presents the results of the evaluation.

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